UNIVERSITY OF NAIROBI
FACULTY OF SCIENCE & TECHNOLOGY
DEPARTMENT OF COMPUTING AND INFORMATICS

DETERMINANTS OF ADOPTION OF MICRO-SERVICES IN DIGITAL BANKING SOLUTIONS AMONG COMMERCIAL BANKS IN KENYA.

By
Kipyego Felix
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SUPERVISOR: Dr. Wanjiku Nganga

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DECLARATION

This project report is my original work and has not been previously presented in part or in its entirety to this or any other university for the award of any degree.

Signature: …… Date: …11/08/2023……

Kipyego Felix

This project report has been submitted for examination with my approval as the university supervisors.

Signature: …… Date: 29 August, 2023

Dr. Wanjiku Nganga

DEDICATION

This work is dedicated to my dear and loving mother the late Mrs. Alice Chumba, my family and my classmates.

ACKNOWLEDGEMENT

I would like to thank the Almighty God for the gift of life and wellness to complete this research project. I would also wish to extent my sincere gratitude to my supervisor Dr. Wanjigu Nganga for the support and dedication throughout the project. To all the departmental lecturers just to mention a few Professor Christopher Chepken, Dr, Evans Miriti and Dr, Stephen Mburu, I say thank you for the mentorship and contributing to my thirst for knowledge.

ABSTRACT

Microservices architecture is a major trend in software development presently. It promotes the componentization concept where a single application is broken down to small and independent services. This study was founded on three research objectives; to determine if Benefits (Usefulness and Enjoyment) affects perceived Value of Microservices Architecture adoption in digital banking solutions, to examine the effect of Sacrifices (Ease of use and Perceived Fee) on perceived Value of Microservices Architecture adoption in digital banking solutions and to examine the effect of perceived value on the adoption of microservices architecture in digital banking solutions among Kenyan Commercial Banks. The study adopted a quantitative descriptive survey approach. The study targeted respondents from commercial banks that had implemented or were in the process of implementing microservices architecture in their digital banking solutions. A total of 76 respondents were randomly selected to participate in the study. Data was collected using a Google form survey questionnaire which contained closed ended questions with sections each tailored on the respondents based on their current roles at the bank. Data was analysed using descriptive and inferential statistics and presented in concurrence with the objectives of the study. One-sample t-test and stepwise regression analysis methods were adopted for hypothesis testing. The study findings revealed that majority of the respondents perceived value 94.1% influenced their adoption of microservices architecture. Consequently, 95.6% of the respondents believed that the usefulness of microservices architecture influenced their perceived value of microservices architecture. The study determined that 93.4% of the respondents based their perception on value of microservices architecture on the enjoyment of the solution after implementation. 92.9% of the respondents believed that costs of implementation for the microservices architecture was reasonable with respect to the perceived value of the technology. All the respondents at 100% agreed that technicality which looked at Ease of use positively influenced their perceived value on microservices architecture adoption. The recommendation of the study was for more studies to be carried out more so from the end user perspective when implementing key financial software solutions.

ABBREVIATIONS

IS-information System

SPSS- Statistical Package for Social Sciences

API-Application Programming Interface

SOA-Service Oriented Architecture

MA-Microservices Architecture

DEFINITION OF KEY TERMS

Microservices- Microservices is an architectural design to development of software applications which breaks down a software system into tiny, autonomous and loosely coupled services, each tasked with a dedicated business functionality. In a digital banking solution, sample services would include a user service for all user related functionality, an account service to manage bank related accounts and information, a transaction service to handle all digital banking transactions, a notification service for all alerts and notifications, a payment service to integrate with payment gateways and handle payment processing, a security service to handle user authorization, authentication and access control and a reporting service for all enquiries and system reports.

Monolithic Architecture-This is a conventional software architectural design where a system is built as a distinct, self-contained unit. Within this style of software design, all the various modules of an application are coupled tightly and interdependent, forming one codebase. Essentially, monolithic architectures comprise of one executable file or a group of tightly coupled services executed within the same process. In a digital banking solution for instance, an application would be structured in a way that it has a User Interface which handles the presentation of the solution to the end user including logging in screens, balance enquiries, funds transfer, payment of utilities among other features, there would also be a business logic component which would house all the logic which tasks like account calculations, reconciliations, validating transactions and enforcing business rules, finally we would have the Data Layer which would manage interaction with the database where all data is stored.

Digital Banking- Digital banking is the delivery of financial services via digital channels. It allows customers to perform banking transactions and access financial products and services through

digital devices. Digital banking services may include account opening and management, money transfers, bill payments, loan applications, investment management, and other financial services.

Bank- A financial agency that accepts customer deposits then reinvests the deposits to make profitable investments. Banks offer a range of financial services, which include mortgages, customer accounts, investment services, credit cards, and other related financial products. Banks are often regulated by government agencies and must comply with various regulations and standards designed to protect customers and maintain financial stability.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

1.1.Background

The banking industry has witnessed significant growth in terms of technology over the past decade, converging banking experience and operating model close to that of other industries and user expectations than ever before (Wewege, 2017). Banks just like other business are continually looking for ways to outshine their competition in offering their customers excellent banking services in a channel that is most comfortable to end users. Consumers have increasingly demanded on remote banking services, fueling demand for digital banking as opposed to conventional banking methods through cheques or cash.

Digital transformation has had a notable impact within the financial sector, driving banks and other similar institutions to embrace emerging technologies to keep up with consumer expectations (Scardovi, 2017). One of the most significant changes in this regard has been the adoption of micro-services architecture, which has become increasingly popular in digital banking.

Microservices architecture is a design to building software applications that emphasizes the creation of small, modular services that work together to perform specific functions within the overall application. In the context of digital banking channel applications, microservices architecture is a way to create a flexible and scalable systems that can support the diverse needs of digital banking channels, including mobile banking apps, online banking portals and agency banking.

In a microservices architecture for digital banking applications, each microservice is tailored to perform a particular task or set of tasks within the application. For instance, one microservice maybe be designed to handle user authentication, while another to process transactions. Each

microservice communicates with the others through APIs (Application Programming Interfaces), which allow them to exchange data and coordinate their activities.

Several studies have examined the adoption of microservices in digital banking applications. A study by Krueger found that microservices are becoming increasingly popular in banking due to their ability to enable rapid innovation, reduce complexity, and increase operational efficiency (Krueger, 2022). Another study by Singleton found that microservices can help banks to reduce their time-to-market by up to 90%, while also reducing their development costs (Singleton, 2016). While microservices architecture offers many benefits, there are also significant challenges in adopting this approach in digital banking systems. One of the main challenges is managing the complexity of distributed systems, as microservices often rely on multiple components and services that need to work together seamlessly. Another challenge is ensuring data consistency and integrity across multiple services, as every service has and individual database and data model. (Heinrich et al., 2018).

1.1.1. Concept of Micro Services

Microservices are a type of software architecture style that has gained popularity in recent years (Dragoni, et al., 2017). They are a way of developing software systems as a set of tiny, and modular services that jointly function together to provide a comprehensive solution. Furthermore, Dragoni et al (2017), also asserts that the approach to software development is particularly well-suited for building large-scale, complex systems that require a high level of scalability, resilience, and agility. Traditional software architectures are typically monolithic, meaning that all application modules are closely coupled and run on a single platform (Mazlami, & Leitner, 2017). This approach can lead to problems such as code duplication, difficulty in scaling, and long development cycles. In

contrast, microservices are logically built to be loosely coupled, with every service tasked with a particular business function and able to communicate using APIs with the other services.

The history of microservices is drawn from the Services Oriented Architecture (SOA), introduced in 2000 (Larrucea, 2018). SOA was designed to help organizations build software applications that were flexible and reusable, by breaking software design into autonomous, self-contained services which can be reused across different applications. However, SOA had some limitations, including a lack of standardization and a tendency towards complexity, which made it difficult to implement in practice.

Microservices build on the ideas of SOA, but with a focus on simplicity, agility, and independence. Microservices are designed to be lightweight, with each service having a single responsibility and a minimal footprint (Sun, & Memon, 2017). This allows for faster development cycles, easier testing and deployment, and better scalability and resilience. Microservices also embrace a DevOps culture, where developers and operations teams work closely together to ensure that the software is delivered quickly and reliably.

1.1.2. Digital Banking Software Applications

Digital banking, commonly referred to as e-banking is use of digital platforms including mobile applications, and other electronic devices to perform various banking transactions and services remotely (Shaikh, & Karjaluoto, 2016). Digital banking provides customers with capabilities to carry out various banking functions, such as account balances enquires, funds transfer, paying bills, opening accounts, and accessing a range of financial services.

Digital banking has gained popularity as it offers customers greater convenience, flexibility, and speed in managing their finances (Lipton, et al., 2016). Traditional banking systems, built on monolithic architecture, have struggled to keep pace with the rapidly changing digital landscape,

resulting in slow innovation cycles and outdated technology. Microservices architecture offers an alternative approach to building digital banking systems, enabling banks to provide a more agile, resilient, and scalable infrastructure. (Alam, 2018). With digital banking, customers can access their accounts and perform transactions 24/7 from anywhere with no need for connectivity to the internet. This is convenient as customers to not have to physically visit bank branches which in most cases have restrictive operational hours saving them on costs and time.

In addition to convenience, digital banking offers enhanced security features such as two-factor authentication as well as fraud detection tools to help safeguard customers' accounts and personal data from unauthorized access (Vishnuvardhan & Lakshman, 2020). Overall, digital banking has transformed the way people interact with financial institutions, providing a faster, more efficient, and convenient way to manage their finances.

To successfully adopt microservices architecture in digital banking systems, it is essential to follow best practices that can help mitigate the challenges and risks associated with this approach. These best practices include designing services around business capabilities, using API gateways for service discovery and communication, implementing fault-tolerant and resilient services, and leveraging containerization and orchestration tools for deployment and scaling. (Jindal et al., 2020).

As digital banking continues to evolve, the adoption of microservices architecture is likely to increase, with more banks adopting this approach to keep up with the fast-paced and highly competitive digital landscape. Overall, the research suggests that the adoption of microservices architecture in digital banking applications is increasing, as banks and digital channel software applications developers look to improve their agility, scalability, and flexibility. The benefits of microservices, including increased innovation, reduced complexity, and improved operational

efficiency, are driving this trend. While microservices have gained popularity in many industries, including banking, there are still some research gaps on the adoption of microservices in digital banking, such as improving the reliability and performance of microservices, balance between the costs and benefits linked with microservices architecture and developing tools and frameworks to simplify microservices adoption and management. (Gu et al., 2019).

1.2.Problem Statement

Digital Banking Solutions within Banks is largely a function of the Information technology department. Some Banks have software developers that built these solutions in house while some outsource it to software development companies that meet their procurement requirements. The biggest headache for IT Managers in banks has been downtimes caused by outage of services due to scheduled updates/upgrades on the Digital Banking solutions, performance hitches when the number of users increase especially during holidays, school openings and end of the month.

The adoption of Micro services in banks is still relatively low, despite the significant benefits that they offer. Traditional banking systems are monolithic in nature, with large, complex architectures that are difficult to modify, scale, or maintain. This lack of flexibility makes it challenging for banks to effectively adapt to dynamic customer needs and industry demands. Micro services, on the other hand, provide a more modular approach to software development, with small, unique services which can be modified, deployed, and scaled easily.

They offer improved agility, resilience, and scalability, which are essential for modern banks to stay competitive in an ever-changing landscape. However, the adoption of micro services in banks poses several challenges, such as the need for a fundamental shift in the way banks approach software development and the requirement for significant investments in infrastructure and talent.

Therefore, the problem is that Despite the growing popularity of microservices as a software architecture style for building digital banking solutions, there are a few studies around the factors that facilitate or hinder the adoption of microservices in digital banking.

1.3.Objectives

1.3.1. Main Objective

Based on the problem statement and reviewed literature, the main objective of the quantitative study was to assess the determinants of adoption of Micro-Services architecture in Digital Banking Solutions Among Commercial Banks in Kenya.

1.3.2. Specific Objectives

1. To determine the effect of Benefits (Usefulness and Enjoyment) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks.
2. To assess the effect of Sacrifices (Ease of use and Perceived Fee) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks.
3. To assess the effect of perceived value on the adoption of microservices architecture in digital banking solutions among Kenyan Commercial Banks.

1.4.Research Questions

1. What is the effect of Benefits (Usefulness and Enjoyment) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks?

2. What is the effect of Sacrifices (Ease of use and Perceived Fee) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks?
3. What is the effect of perceived value on the adoption of microservices architecture in digital banking solutions among Kenyan Commercial Banks?

1.5.Significance of the Study

Digital Banking in Kenya is relatively at an advanced stage with majority of Commercial Banks having adopted it. There is a major risk that an information Technology failure could result in service disruption, preventing access to critical services such as digital banking, hampering customers access to their money thus discouraging consumer confidence.

Launching a digital banking solution for Financial Institutions is a costly affair for banks. Consequently, Banks have to maintain the platform after launch, as a result of service spikes during holidays, end of the month and schedule events such as school openings normally strain digital banking solutions as they compete for resources with other banking systems. Although most banks have adopted digital banking solutions, most of them still report mixed results with regard to usability where some are struggling while others have high performance, which thus validates the importance of this study in offering recommendations for adoption of Micro services with the intend of improving performance and resilience.

Study findings will help top management of commercial banks and other financial institutions through informing them on possible approaches to speed up adoption of micro services as well as how to maneuver through common challenges. Furthermore, Banks will take advantage of the study findings to create a strategy on how to fully harness the benefits of technology.

1.6.Scope of the study

This research was conducted Kenya, Nairobi county where most banks headquarters are based. The focus of the study was assessing the determinants of adoption of Micro-Services architecture in Digital Banking Solutions Among Commercial Banks in Kenya with emphasis on factors drive or hinder the adoption of microservices in banks, economic benefits and costs associated with the adoption of microservices in banks and the adoption of microservices effect on the customer experience in the banking industry.

1.7.Organization of the study

This project is divided into five chapters. The first Chapter offers the background to the study, research questions and objectives, the scope and significance of the study as well as assumptions. The second chapter reviews related literature and offers a theoretical model that the study was founded on. The Third chapter presents the research methodology, while the fourth chapter highlights the findings from the study and discussions. The final chapter concludes the study and offers some recommendations.

CHAPTER 2

LITERATURE REVIEW

2.1. Micro-services Architecture

A straightforward framework for structuring application logic, was first introduced by Jackson structured pro-gramming where it advocated for the maintenance of a subroutines library, each of which would achieve one functionality well (Jackson, 1975). This fosters modularity as well as code reuse. The next phase was Object orientation which concentrates on establishing code-block abstractions as a group of services which can be called by other objects (Hoare, 1972).

Abstraction is simply the separation of the object interface from internal object implementation through abstraction of how objects are used from how they work., this reduces dependency on the client upon the objects (Snyder,.1993). Abstraction allows internal objects to be sophisticated, normally using services of other objects for purposes of business logic, data transformation and data calculations. Decent modularity and well-orchestrated encapsulation leads to highly reusable objects. Consequently, object based development is largely deemed to be development at low granularity (Snyder,.1993).

The next development was component based system development where a number of objects are packaged together as a component to achieve higher levels of granularity (Alahmari,.2010). The justification is that as opposed to objects, components would result in better productivity through enhance granularity thus simpler to translate business logic. The next phase was service oriented architecture where a services brings together multiple components to offer discrete business function. The service layers permit standard industry protocols, which simply access to the service hence enhancing interoperability. The current phase is microservice architecture where software

development is broken down into small independent services which communicate via well-defined secure APIs (Shadija,.2017).

Microservices architecture has increasingly become an approach of choice when building distributed systems. As opposed to monolithic applications, microservices is loosely coupled such that every service runs independently of the other (Kalske & Mäkitalo, 2018). A microservice has business logic as well as internal storage of data for autonomous services. This is a unique difference as compared to conventional architectures, as it includes an entire application within a single service. Consequently, a set of microservices comprising of distinct autonomous services function as a group of tiny services (Fowler, 2019). Fine grained autonomous services are easy to maintain due to the size of services as well as their organization, where if one service goes down, the entire application shall not be affected. It renders modules easy to replace and independent project stakeholders are able to update and patch the system on their own (Mazzara, et al., 2017). As a result of the structured manner of microservices and how they function self-sufficiently, they rely on inner communication amongst the services. Microservices are autonomous in terms of programming language suggesting that modules communication is not restricted to function calls or language level methods (Microsoft, 2021).

2.2. Benefits of microservices

Several studies have highlighted the benefits of using microservices in digital banking. For example, they enable greater agility and scalability, as well as easier integration with third-party services. Prathap, & Saravanan, recommend that as you implement microservices architecture, it makes it possible to reuse code, integrate with other systems through APIs and expose them to 3rd party services (Prathap, & Saravanan, 2019).

Some studies have also shown that microservices can improve the overall performance of banking systems. According to Jbsolutions, when you need to scale up performance of a monolith, you have the option of increasing RAM, additional processors or huge servers. However, if you have reached a limit, then sharding comes to perspective. Sharding helps to decompose a huge database and distribute traffic accordingly to better performance (Jbsolutions, 2021). As opposed to monoliths, microservices could be deployed to separate hardware, such that you can achieve scaling and performance benefits out of the box. Given that microservices have independent databases that holds information required by services, every microservice could distinctively and comprehensively be scaled up or down, saving on expenses (Bucchiarone, et al., 2018).

According to Bayloy & Dimoy, Microservices have a small codebase such that developers do not need to understand the entire application to make a change in a service (Bayloy & Dimoy 2016). This scales down the time needed in troubleshooting issues and fixing them. Tiny services can be built, deployed and executed quickly. Due to the high automation levels of microservices this can be realized in seconds.

Prathap, & Saravanan, asserts that since there is no need to service dependency while designing the software, microservices adaptation aids in doing away with the reliance on domain experts (Prathap, & Saravanan,2019). To make changes to an application, anyone can independently perform their roles using dummy data without the need for a domain expert. Given that all inputs are clearly stipulated, training costs can be scaled down. Furthermore, they argue that for unused services, costs associated with maintaining them can be cut off. This can assist organizations to cut 40% of Information Technology resources and realizes between 20 to 50% overall cost savings (Prathap, & Saravanan, 2019).

According to Singleton, 2016, microservices offer ability to easily control server capacity when compared to monolithic systems (Singleton, 2016). In addition, the capacity of servers can be load balanced from an over utilized server to a less utilized server hence avoiding shortcomings (Singleton, 2016). Such scalability and flexibility with regard to server utilization makes microservices architecture less costly as opposed to monolithic systems (Newman, 2015).

Microservices also help to improve the overall security and resilience of digital banking systems. By isolating individual services, banks can limit the impact of any potential security breaches, reducing the risk of system-wide vulnerabilities. This approach also helps to improve the fault tolerance of digital banking systems, as failures in one service are less likely to affect the entire system (Barbulescu, 2023). In summary, microservices architecture is becoming increasingly popular in digital banking due to its ability to improve agility, scalability, and resilience. By building modular, independent services, banks can respond more quickly to customer needs and market changes, while also improving the security and reliability of their systems.

2.3. Challenges of microservices adoption

Though the benefits of micro services are known, there are also some shortcomings on its adoption. Data management and consistency is one challenge given the distributed nature of microservices (Söylemez,.2022). The shortcomings are about management of distributed transactions as well as data backups and integration. Backups of the whole application broken down into microservices consists of some disadvantages, hence a challenge undertaking a backup of the whole system while simultaneously ensuring consistency and availability (Söylemez,.2022). Microservices can operate on common data through unique connections without a coherent architecture, though this makes it sophisticated.

Testing also has a vital part in any application, for both developer and user confidence. Nevertheless, for microservices, it is a cumbersome task to meet as a result of the microservices distributed nature (Söylemez,.2022). Every microservice resides within some distributed set-up and could be designed and coded using a number of languages or technology making testing more complex.

Where there is not so much data, it could take too long to develop a microservices based system than is necessary hence wasting resources and time (Singleton, 2016). Sturtvant (2018) adds that microservices are ideal for huge sophisticated systems. Team management is also complex in microservices architecture. The thought process is unique to the monolithic one, hence team members have to continuously learn (Newman, 2015).

In microservices architecture, project stakeholders are autonomous and tasked with small clear system components. It becomes a challenge during transition though leads to positives eventually (Villamizar et al., 2015). Change management is critical and lack of adequate management could make transition very costly and challenging. Management is also imperative since the system is broken down to small segments that require broad overview (SaM Solutions, 2017). Hall, & Khan, (2003)

Assert that adoption of technology is in most cases very costly for a number of reasons including new hardware purchase and the technology itself. Furthermore, given that entities in this case already have working solutions, considering that they also have competing budgetary interests, the motivation towards adopting a new technology may be less.

Generally, there are positives in most cases as opposed to negatives with regards to microservices, even for smaller systems. According to Singleton (2016), particularly for smaller systems, shifting to microservices is not essentially the correct choice. Microservices could lead to needless

complexities or hamper the software development process at the inception of a project (SaM Solutions, 2017).

2.4. Case studies of microservices adoption in digital banking

There are several case studies available that showcase the successful adoption of microservices in digital banking. These case studies can provide insights into the best practices for adopting microservices and overcoming the associated challenges.

Capital One, a US-based bank, adopted the architecture to enhance the scalability and agility of its digital banking platform (Trivedi, 2022). The bank upgraded its architecture, which enabled it to rapidly deliver new features and services to its customers (Trivedi, 2022). The microservices architecture also helped the bank improve on time taken to roll out new solutions/services around the digital banking space.

Lloyds Banking Group, a UK-based bank, adopted a microservices architecture to enhance the agility and scalability of its digital banking platform (Chironga, et al., 2018). The bank's microservices architecture allowed it to rapidly deliver new features and services to its customers, and it also helped the bank to deploy new services/solutions quickly (Chironga, et al., 2018). The bank also used microservices to improve the performance and reliability of its digital banking platform.

Deutsche Bank, a German bank, adopted a microservices architecture to enable them built and deploy digital products and services faster (Redhat, 2019). The bank's microservices architecture was designed to be flexible and scalable, and it allowed Deutsche Bank to effectively address dynamic needs from customers as well as any industry needs (Redhat, 2019). The bank also used microservices to improve the performance and reliability of its digital banking platform.

Ecobank, a Pan-African banking group, adopted microservices architecture in order to better the speed and scalability of its digital banking platform (CHEREDNYCHENKO, 2020). The bank migrated its legacy systems to a microservices architecture, which allowed it to develop and deploy new digital products and services quickly (CHEREDNYCHENKO, 2020). The bank's microservices architecture also enabled it to enhance customer experience by providing real-time services and personalized offerings.

NCBA Bank partnered with Murong Technology as well as Huawei to build a state of the art hardware and software infrastructure (Owino, 2020). The bank adopted a modern distributed core banking system that embrace microservices software architecture. NCBA were able to improve reliability and resilience of services and improved customer experience (Owino, 2020). Furthermore, the platform allows the Bank capability to take its flagship products Fuliza and Mshwari beyond current offerings to address the underserved market segments.

2.5. Effect on Usability

Digital banking is all about delivering a seamless and personalized usability. Some studies have explored how the adoption of microservices can affect Usability. According to ENTERPRISE MANAGEMENT ASSOCIATES (2016), Consumers anticipate prompt iterations with regard to new functionality, improved performance and availability as well as good functionality despite the device in use or the environment where the user uses the service from (ENTERPRISE MANAGEMENT ASSOCIATES, 2016).

A partial solution to the high expectation levels from customers by digital businesses is shifting to microservice architectures. For example, microservices can enable banks to offer more personalized products and services, as well as faster and more convenient customer service. From a business perspective, adoption of a microservices based architecture improves time to market for

change roll outs. Entities are able to launch new functionality faster while end users have an instant access any latest roll outs in terms of services or functionality (ENTERPRISE MANAGEMENT ASSOCIATES, 2016). The power to securely and quickly improve products and services to foster business outcomes now plays a vital role.

According to a study by McKinsey, 84 percent of business executives believe that their success in the future is based on continued innovation (McKinsey, 2023). However, innovation is not the only cure as the speed at which businesses come up and deliver such innovations should also be a concern for business looking to gain and retain competitive advantage while boosting their customer's capabilities. With microservices, Banks can innovate more quickly to persistently bolster their customer experiences. Microservices allow the Bank team to proactively react to customer expectations fast as well as introduce new product features to further improve capabilities.

2.6. Costs and Migration to a Microservices architecture

A study by Shaik et al., 2021 found out that the biggest impediments to adoption of new technology are cost of technology and infrastructure, adoption challenges, technical skills, lack of organizational support among others (Shaik et al., 2021). According to Mike, 2020, most microservices projects are meant to replace legacy monolithic applications, and given that such software are complex and have evolved over time. The Ease of use of applications that are faced out implies losses which in most cases, organizations have not reaped the benefits fully, furthermore, the software are being upgraded to support new functionality (Mike, 2020).

Adoption of microservices may require organizations to pay the complexity costs again, in which most organizations may not be willing to. However, consequently, organizations gain increased flexibility, simpler management and simplified scaling (Mike, 2020). According to Ferguson,

2022, Microservices come with a cost, furthermore, every microservices added to production environment comes with associated costs of test suites, hosting infrastructure, deployment playbooks among others (Ferguson, 2022).

Baskarada et al., 2018 notes that Microservices architecture is a promising solution which conjugates maintainability, scalability, reduce infrastructure costs, ease of deployment, resilience, heterogeneity, reusability among others (Baskarada et al., 2018). Adoption of a microservices architecture might cause problems that have costs implications to organizations that want to adopt it. However, the benefits that the architecture offer outweigh the costs. It is imperative to shed more focus on the gaps between the costs and benefits associated with the architecture. Common opinions of Microservices architecture in different fields would help practitioners, particularly those who are adopting the architecture for the first time, in carrying out the implementation efficiently and successfully.

2.7. Research Gaps

A literature review on the adoption of microservices in banks reveals that this technology is gaining popularity in the financial industry, but the adoption rate is still relatively low. Several studies suggest that the primary drivers for the adoption of microservices in banks are improved agility, flexibility, and scalability, which are essential for addressing customer dynamic needs and staying competitive within the market.

However, the literature review also highlights several challenges that banks may face when adopting microservices. These include the need for a significant shift in the way banks approach software development, which requires changes to the organizational structure and culture. Banks also need to invest in the necessary infrastructure and talent to support microservices, which can be a significant financial burden.

Overall, empirical evidence points out the fact that the adoption of microservices in banks is a complex process that requires careful planning, investment, and management. While the benefits of microservices are clear, banks need to carefully evaluate their organizational readiness and risk management capabilities before embarking on this journey. Digital banking is one of the areas that has seen significant adoption of microservices architecture due to its ability to provide agility and resilience to banking systems. In this literature review, we explored the research and literature related to the adoption of microservices architecture in digital banking.

Further research is needed to discover the elements that promote or constrain use of microservices in digital banking and identify strategies to mitigate them. The adoption of microservices in digital banking can have a notable consequence on end user experience. Further studies are needed to comprehend how microservices could be employed to foster end-user experience and identify any potential challenges that could arise.

While microservices architecture can improve performance and scalability, there are concerns around the ability of microservices to handle high volumes of transactions in real-time. Further research is needed to ascertain frameworks to promote performance and scalability of microservices in digital banking.

Most of the literature on costs of microservices adoption is theoretical or based on case studies and is also on general industrial systems as opposed to the Banking domain. There is a need for more studies to understand the real-world cost challenges and solutions in implementing microservices-based systems in banking.

2.8. Theoretical Framework analysis

This study reviewed three theoretical frameworks to help the study in explaining the relationships between the variables. The reviewed models are;

1. Technology-Organization Environment Framework
2. Technology Adoption Model
3. Value based technology adoption model

2.8.1. Technology-Organization Environment Framework

This model was coined by Tornatzky and Fleischer (1990), to analyze the adoption of new information technology technologies within an organizational context. The framework focused on the impact of three central factors Technology, organization and environment on an organizations new technology adoption decision. The technology component elucidates the firm's internal and external technologies of the firm and how adoption of new technology can stimulate the firm. The organization perspective focuses on the various measures within the organization. Such measures have a huge impact on the technology adoption decision. The environmental perspective focus on a business operating environment, the competition, industry as well as government.

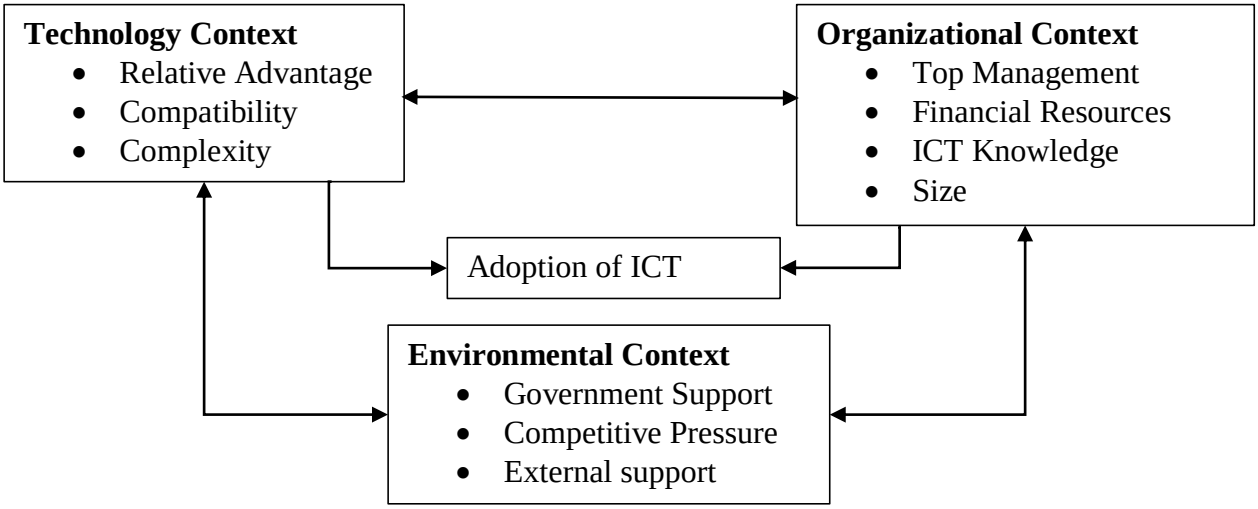


Figure 1: Tornatzky and Fleischer (1990), Technology-Organizational and Environmental Model

The constructs within the Technology-Organizational and Environmental contexts have been adopted by a number of scholars (Musawa and Wahab, 2012), who have largely strengthened its conjectural underpinnings and earned validity as well as reinforced several information system enquiries. Nevertheless, Tornatzky and Fleischer (1990) hardly advocated for a rigid framework and hence other researchers proposed integrating the model with other models so as to augment its conjectural perspectives. Premkumar suggests that it's insufficient to reflect on the contexts of T-0-E theoretically but instead, capabilities of the framework are boosted when discrete tasks perspectives along with their cognate aspects are unified (Premkumar, 2003).

2.8.2. Technology Adoption Model

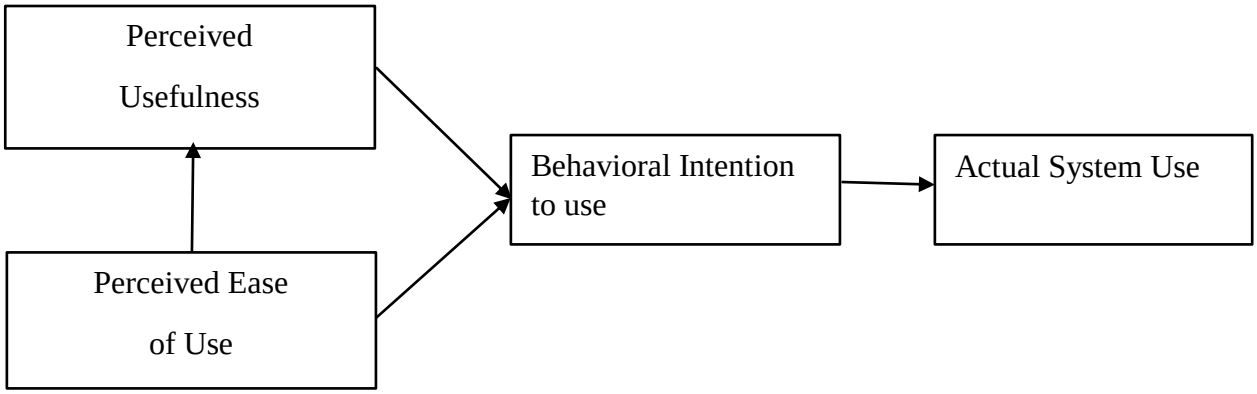


Figure 2: Davis, 1989, Technology Adoption Model

The framework was developed to help in predicting the attitudes of consumers towards new technology. Technology adoption model focuses on innovation adoption via two elements (perceived usefulness and Perceived Ese of use). Usefulness in this case is simply an attitude that adopting a specific technology increase productivity. Ease of use perception is the trust that use of a specific technology would be seamless (Davis, 1989). The external aspects including language, enabling environments, cultural and administrative aspects impact these constructs.

The framework elucidates linkages between people variables including attitudes, opinions, intentions and ease of use of the technology to be adopted (Davis, 1989). TAM focuses on user behavior and ascertain why a specific technology is not accepted, then puts in place the necessary corrective measures. It is intended to help researchers understand the casual relationship between user adoption and technology utilization variables. The model is argued as being too simplistic in justifying conclusions derived from various scenarios with extra variables needed to exhaustively understand user decisions (Legris, et al., 2003).

2.8.3. Value Based Technology Adoption Model

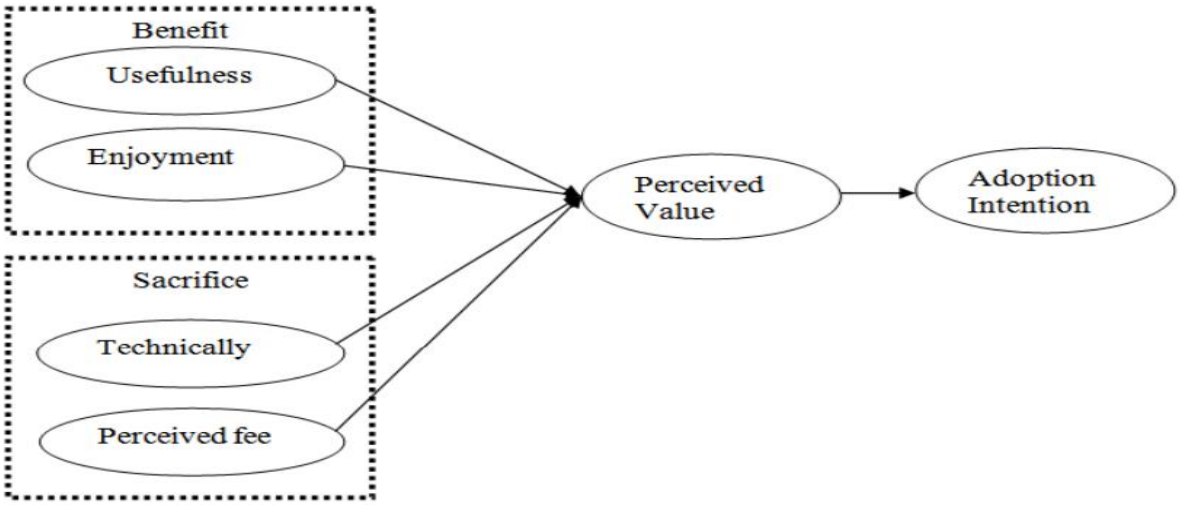


Figure 3: Value Based Technology Adoption Model (Hee-Woong Kim et al., 2007)

According to Kim, Chan, and Gupta (2007), the adoption intention can be predicted via perceived value. Perceived value is defined on the context of balance based on benefits and sacrifices as well as the classification of motivators as either extrinsic or intrinsic. This model was designed to address the shortcomings of the technology adoption model, given the factors that affect perceived value. While TAM was designed on the basis of perceived usefulness and perceived ease of use variables to elucidate and predict customer intent on technology adoption, the value based

technology adoption model is founded on technology benefits as well as the sacrifices to adopt them.

2.9. Conceptual Framework

The study adopted the Value Based Technology adoption model constructs to address the problem under study. The study adopted six constructs Extrinsic Benefit (Usefulness), Intrinsic Benefit (Enjoyment), Technicality Sacrifices (Ease of Use and Perceived Fee), Perceived Value and Technology Adoption.

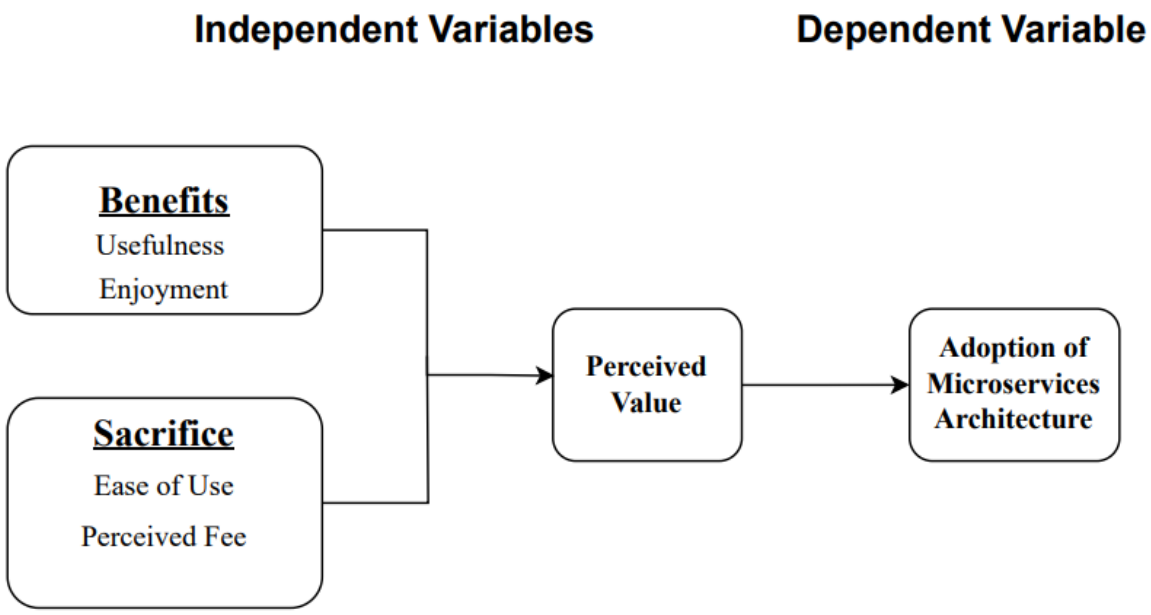


Figure 4: Conceptual Framework, Source, Value Based Technology Adoption Model (Hee-Woong Kim et al., 2007)

The study adopted Ease of use as a technicality element, in which Davis, 1989 adopted as a technicality construct (Davis, 1989). A study by Cronin et al, revealed that extensive mental costs influences perceived total costs to the end-user. Another study by Venkatesh, et al., 2003 found out that ease of use is a notable determinant for new technology embracers as opposed to user

experience (Venkatesh, et al., 2003) Hence, this study adopted Ease of use as a technicality element.

2.10. Hypothesis Development

Based on adopted Conceptual Framework Value Based Technology Adoption Model, the following Hypothesis were developed for the study.

Benefits

Motivations are classified as being either extrinsic or intrinsic on the basis of the Cognitive Evaluation Theory. Extrinsic motivation basically implies carrying out of a task to realize a particular objective while intrinsic motivation refers to carrying out a task for no particular benefit other than just doing it (Deci, 1971). Previous scholars have found that extrinsic and intrinsic factors influence perceived value as well as the behavioral intention, which has also been applied to information systems (Moore, & Benbasat, 1991; Rogers, 1995). This study thus proposes usefulness and enjoyment as the benefit aspects of perceived value.

Extrinsic benefit: usefulness

Usefulness is basically the optimum value that an end-user recognizes from use of a new technology, the technology adoption model views perceived usefulness as an expectancy outcome as well as a measure of extrinsic motivation (Rogers, 1995). Performance expectations including perceived usefulness which concentrates on job achievement, echo's on a person's desire to participate in a task as a result of external benefits. The usefulness element is similar to product quality ideology in marketing which focuses on the purchaser's mental appraisal of a product's supremacy.

A number of studies have shown evidence towards the quality of products having some positive influences on their perceived value and this study expects the usefulness construct to have a similar

effect (Steenkamp, 1990). A number of studies have looked into the usefulness construct with strong empirical evidence pointing at it as a key predictor of technology adoption. The study therefore hypothesized;

H_1 Perceived usefulness has a positive effect on the perceived value of adoption of microservices architecture in digital banking solutions.

Intrinsic benefit: enjoyment

Individuals who prefer using technology and deem use of technology as an enjoyable activity from the fundamental contribution of technology have a higher probability of adopting it or appreciate its adoption more than others (Davis, et al., 1989). Enjoyment in this context is the degree where the usage of a product is perceived to be fun exclusively, distinct from the performance value that might be projected. Some studies have also found out that the benefit aspect comprises perceived enjoyment further to perceived usefulness and that enjoyment as well as fun have a notable effect on technology acceptance beyond just usefulness. The study thus hypothesized;

H_2 Enjoyment has a positive effect on the perceived value of adoption of microservices architecture in digital banking solutions.

Sacrifices

Sacrifices are both monetary as well as non-monetary. Monetary sacrifices comprise of actual product costs and is largely determined on the basis of the perception of the material product cost of the product (Thaler, 1985). Non-monetary cost often includes facilitative costs to ensure implementation of the technology. For this study we adopt the constructs from the value model namely perceived fee and technicality.

Non-monetary sacrifice: technicality

DeLone and McLean in their information success model define technicality as the extent to which a technology is perceived as outstanding in service provision (DeLone & McLean, 2003). The perception of Microservice adoption is determined by technical and non-technical users, usage, implementation, maintenance and system reliability (consistent reliability and security). Ease of use has been largely adopted as a technicality element.

Some literature indicate that Ease of use is a noteworthy consideration for technology adopters as opposed to experienced users. Particularly, it has been revealed that complexity of the technology has a notable negative effect with the adoption of the new technology. In a microservices architecture perspective, response time of the digital banking solution can be deemed as time costs while ease of use considered as the effort costs. For this study we adopted the Ease of use and System quality as elements of technicality.

H_3 Ease of use has a negative effect on the adoption of microservices architecture in digital banking solutions.

Monetary sacrifice: perceived fee

The perceived price signifies the overall cost of acquisition and implementation of a technology. Some studies have found that perceived fee directly influences the perceived value. Research in marketing reveal that the perceived monetary costs and perceived value are negatively related. We therefore hypothesized;

H_4 Perceived fee has a negative effect on the adoption of microservices architecture in digital banking solutions.

Adoption Intention

The economic utility theory asserts that customers attempt to gain maximum satisfaction with their resource constraints. The study hence compared benefits with sacrifices as an indicator of adoption intention in line with the Value Based Technology Adoption Model. The fundamental ideology of the value concept is measured over perceived gains and losses to some central of neutral reference point, implying that users tend to align with cognitive comparisons as opposed to absolute levels, implying that sacrifices hurt more than the satisfaction given by benefits. We therefore hypothesized;

H_5 Perceived Value has a positive effect on the adoption of microservice architecture in digital banking solutions.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. Introduction

Research Method is an integral component of any research. This section details the design for gathering, measuring and analysis of data. According to Maruyama, & Ryan, a research design is an array of elements for collecting and scrutinizing data in a manner that targets to harmonize the research purpose with procedure (Maruyama, & Ryan, 2015). This section analyzes all matters related to the design and development of research methodologies that were employed in this study. Below subsections are included in the research method; research design, data source, sample size, analysis of data, validity, and reliability.

3.2. Research Design

A research design is a general strategy for linking the study's conceptualized problem to relevant empirical research (Van, 2012). This can be interpreted to mean that it articulates the required data, methods of gathering the data, how the data was analyzed as well as how the study answered its research questions. Research design is key as it reveals whether the researcher was able to obtain solutions to the problem that was being researched on. When it comes to providing answers to questions in research, a research design is the all-embracing technique that incorporates the procedure of gathering and analyzing the requisite data (Saunders et al., 2009).

It is important to choose a research design that aligns well with the study's objectives and questions. This study reviewed research designs with an aim of ascertaining the best quantitative design. According to Haegele & Hodge, (2015), quantitative researchers can select relational, experimental or descriptive designs (Haegele & Hodge, 2015). The best design must align with the goal and provide responses to research questions as well as hypothesis. Consequently, for the

Assessment of the determinants for adoption of Micro-Services in Digital Banking Solutions Among Banks in Kenya, a quantitative descriptive technique was established to be suitable for this study.

Kshetri (2010), asserts that a descriptive research is developed to gather relevant and accurate information status about the phenomena under study. Furthermore, descriptive research designs are employed in preliminary and exploratory studies to permit the researcher obtain, summarize, present and interpret information for the purpose of classification (Creswell (2012).

3.3. Target Population and Sample Size

The study targeted Information technology managers and staff directly involved in financial technology adoption in Banks within Nairobi as well as technology vendors who provide such technologies to financial institutions. Based on the Central Bank of Kenya, by 2023 there were 38 licensed commercial banks in Kenya. This includes both local and foreign banks operating in the country.

Clustered sampling was adopted for this study, where target respondents were divided into clusters; the first cluster comprised of senior heads of ICT departments, the second group comprised of resources involved in ICT projects implementations in Banks and the third cluster comprised of system end users. To obtain a justifiable sample size, the study adopted the slovins 1960 formula with a 1% error margin.

$$n=N/(1+Ne2)$$

Where; n= Number of samples

N= Study Population

e= Error Tolerance

$$n=38/ (1+38(2/100)^2) =38$$

Random sampling was applied in the study to guarantee that vital decision makers were included as part of the sample. This is essentially a non-probability sampling procedure where chosen target respondents are within the researcher's reach. Aside from being vital decision makers, the selected sample represented key drivers and champions of ICT technologies in Banking. From the 38 Banks, 76 respondents were randomly selected for the study.

3.4. Data Collection Methods

Top Information Technology managers and IT stakeholders in Banks were sampled for this research, which focused on Kenyan Commercial Banks. Quantitative techniques were used to gather primary data; Research data was gathered using questionnaires with structured closed ended questions. The questionnaires adopted Google Forms as a result of their convenience in data gathering. A scrutiny of agreement with various statements regarding determinants for adoption of Micro-Services in Digital Banking Solutions was given to respondents.

The survey tool was divided into sections based on user roles which eventually led to three questionnaires, IT managers and Director IT formed the respondents for the first questionnaire, project managers, system developers and implementers formed the respondents for the second questionnaire while Application End users also formed the respondents for the last questionnaire.

The closed ended questions provided structured quantitative data and uniformity in responses which made data analysis easier and facilitated tangible recommendations.

3.5. Data Analysis & Interpretation

After gathering of quantitative Data using survey questionnaires, prior to processing of responses, the researcher checked them for consistency and completeness. Data was then grouped into

categories, coded and fed into SPSS statistical analysis tool. Data was presented using measures of central tendency, tables, percentages and frequency counts to describe distributions. Information drawn from this analysis was be presented using charts.

Descriptive analysis tools were used to visualize the sets of categories derived from the data. Inferential statistics we adopted in drawing meaningful conclusions based on gathered data. Inferential statistics focuses on the different tests of significance in testing hypothesis so as to ascertain with what validity data can be said to suggest some conclusions. According to Kothari (2004), interpretation, depiction of conclusions or interpretations is mainly based on inferential analysis (Kothari, 2004).

The study also applied other inferential statistics including Pearson correlation and One sample t-test. Two ranges for the 5-point Likert scale were adopted: negative (1 – 3.4), neutral (3.5 – 5). One-sample t-test adopted used to ascertain the degree of significance of the positive scores with a test value of $\mu = 3.5$. The hypothesis was tested through one sample t-test statistic with a mean sample where: Ho: $\mu < 3.5$, against H1: $\mu > 3.5$ as any value < 3.5 was deemed to be below the neutral point hence not indicating any positive influence.

This technique has been adopted by other studies including Wavomba & Sikolia, (2015) in the analysis of their studies based on the recommendation of Creswell (2009) who asserted that for grouped information research designs within the independent variable, studies need to employ *t* tests for contrasts.

The relationship between variables was checked using regressions analysis. According to Kothari and Garg (2014) a good measure of relationship between two variables is given by correlation

coefficient which indicates the extent of strength of the connection as well as the direction of the connection.

3.6. Validity and Reliability

For a research tool to be deemed reliable, it should be able to correctly measure a variable and yield similar outcomes over a pro-longed period of time (Brown, 2001). Pilot tests were employed to determine the reliability of research instruments through evaluation using an independent sample prior to being administered to the actual study sample. Furthermore, according to Blumberg & Schindler (2014), a research tools validity is what ascertains if the tool measures what it was intended for. This study ensured that the questionnaire questions supported all the objectives of the study and measured the variables of the study. In the pilot phase, the researcher used 5 respondents and the survey questionnaire was deemed adequate for data gathering that was critical to achieving the study objectives.

3.7. Ethical Issues

As observed by Blumberg & Schindler (2014), the intention of research ethics is to guarantee that stakeholders are not affected negatively by the research process. Consequently, the researcher adhered to the ethical issues related to confidentiality, integrity, honesty and respondent's rights. The study embraced the highest standards of ethics throughout the study with anonymity of respondent's personal information.

CHAPTER 4: RESEARCH FINDINGS AND DISCUSSIONS

4.1. Introduction

This chapter presents the finding of the study. It includes data analysis, research findings presentation and interpretation. The analyzed data is organized within thematic areas as per the research objectives.

4.2. Demographic Information

Out of the sample of 76 survey questionnaires dispatched, 64 were filled. This represents a response rate of 84 percent which is valid statistically on the basis of Babbie (2020) who asserts that a response rate above 70 percent is sufficient for research analysis. Out of the 64 responses received, 76.6% persons asserted that the banks that they work with had adopted the Microservices architecture in their Digital Banking Solutions while 23.4% had not, as illustrated in **Figure 5**

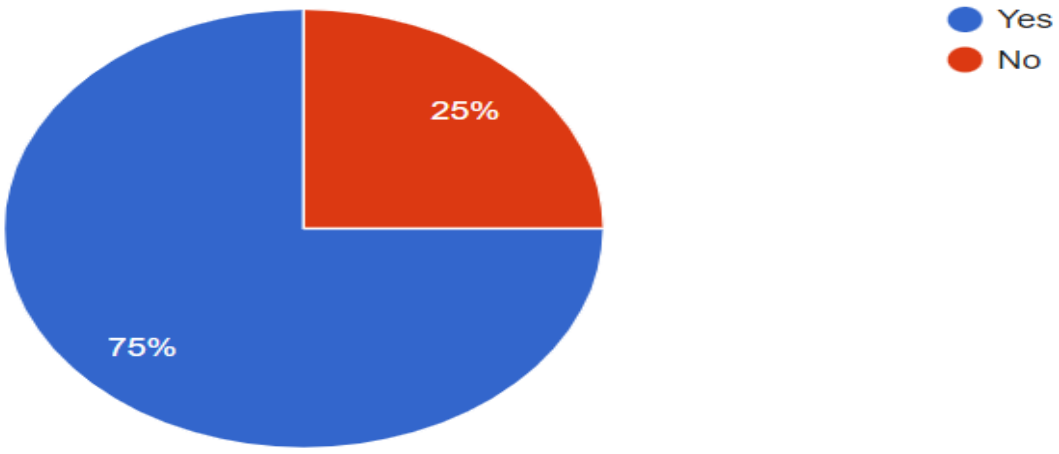


Figure 5: Implementation of Microservices in Digital Banking Solutions

Questionnaire	Response Samples
1	14
2	20
3	15
Total	**49**

Table 1: Responses from Questionnaires

4.3. Reliability and Validity

Prior to corelation of the study variables, it was critical to understand the level of their reliability. Realiability measurement was caried out using Cronbach's Aplha coefficient, with a coefficient above 0.70, the research instruments were deemed as reliable (Bland and Altman, 1997). The variables internal consistency was acceptable given that it was above 0.70. Below table shows the respective outcome of reliability and valididty analysis of the data used.

	Reliability Statistics		
	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Perceived Value	.762	.767	3
Usefulness	.719	.721	5
Enjoyment	.778	.773	3
Technicality	.781	.783	2

Table 2: Reliability Statistics using Cronbach's alpha (Source SPSS)

4.4. Roles

The researcher also sought to determine current respondent's roles so as to ascertain which questions they were best suited to answer. The results are illustrated in Figure 6

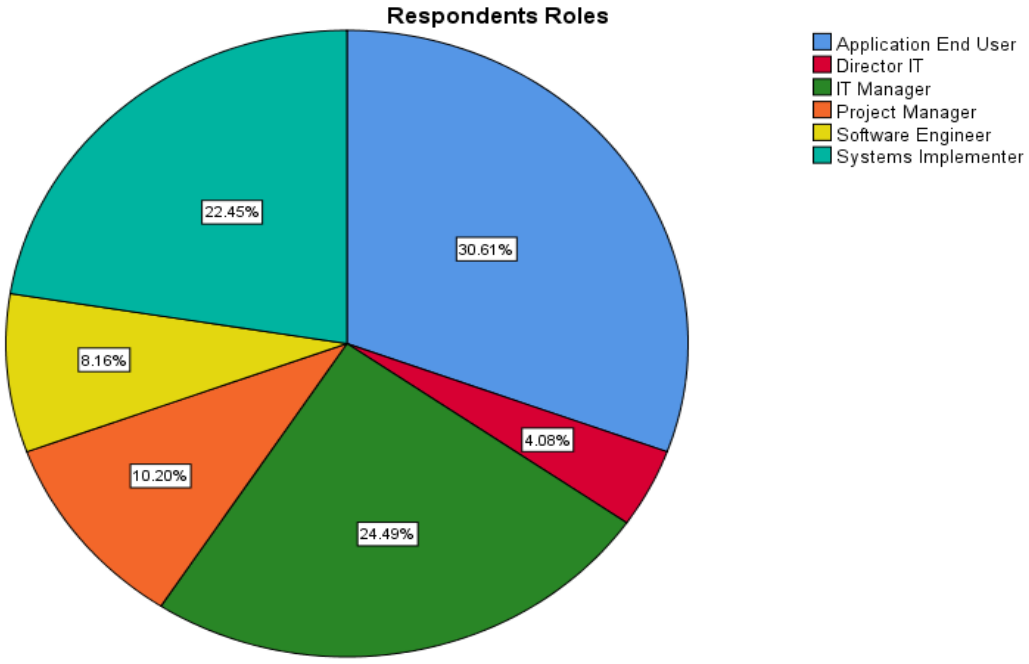


Figure 6: Respondents Current Roles

Majority of the respondents were application end users at 30.61% while the fewest respondents were Directors in IT, 24.49% were IT Managers who serve just below Director IT's and are equally involved in key decision making. 22.45% were system implementers, 8.16% Software Developers and 10.2% Project managers, the group are equally vital in software development projects in Banks which Microservices Architecture implementation fall into.

4.5. Microservices Architecture Adoption Intention Constructs

The study then sought to determine whether the respondent's organizations had plans to implement Microservices Architecture in their Digital Banking solutions or other solutions in the near future.

The results are illustrated in Table 3

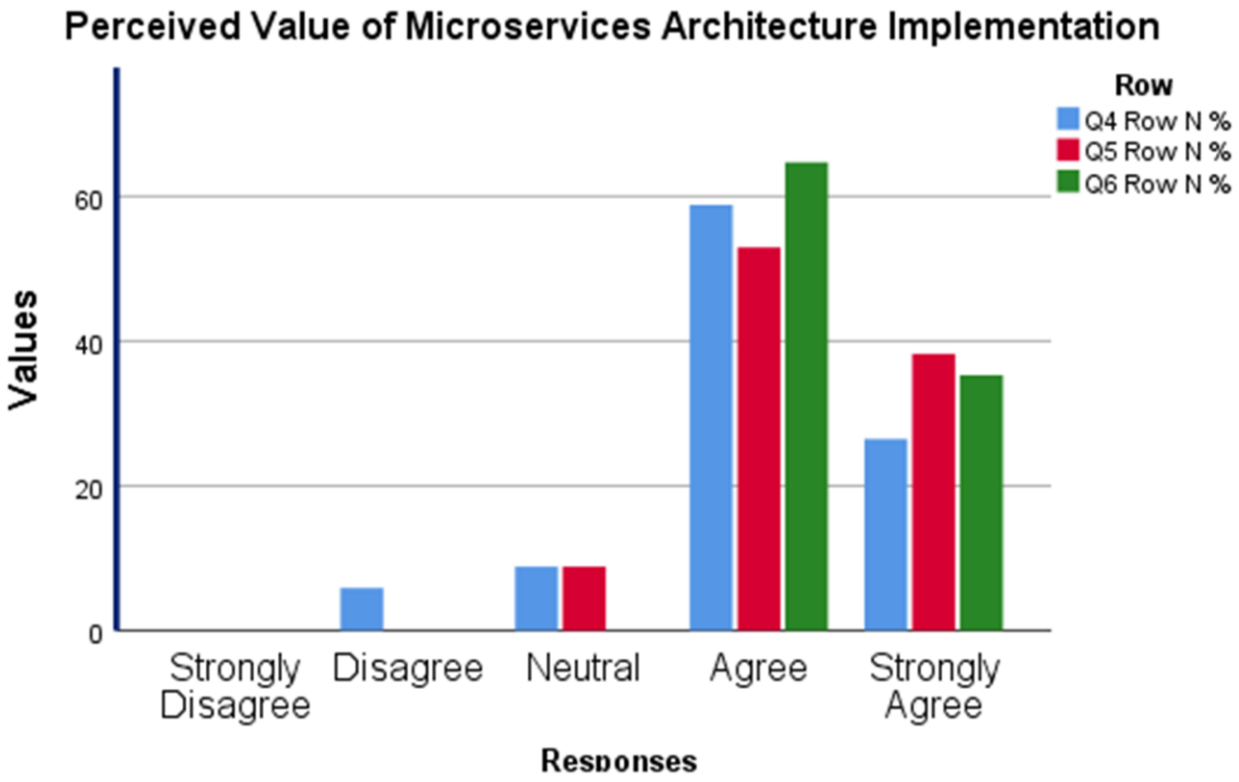
Q3					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	2	4.1	5.9	5.9
	Agreed	15	30.6	44.1	50.0
	Strongly Agreed	17	34.7	50.0	100.0
	Total	34	69.4	100.0	

Table 3: Plans to Implement Microservices Architecture in the Near Future (Source SPSS)

The study findings indicate that 50% of the respondents Strongly affirmed that the banks that they work with had plans to implement Microservices Architecture in their Digital Banking Solutions or other technology solutions in the near future. 44.1% also agreed that their organizations had plans while 5.9% gave a Neutral response to indicate that they could not give a certain response during the study. This suggest that a huge number of Kenyan Commercial Banks have plans to roll out Microservices architecture in their software applications in the near future at 84.1 percent. It is also noticeable that all top ICT management who participated in the study strongly agreed that their organizations had plans to adopt microservices architecture.

4.6. Perceived Value of Microservices Architecture

The study explored the Perceived Value of Microservices Architecture in Digital Banking Solutions among Kenyan Commercial Banks. The responses are illustrated in Figure 7



		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Q4	Row N %	0.0%	5.9%	8.8%	58.8%	26.5%
Q5	Row N %	0.0%	0.0%	8.8%	52.9%	38.2%
Q6	Row N %	0.0%	0.0%	0.0%	64.7%	35.3%

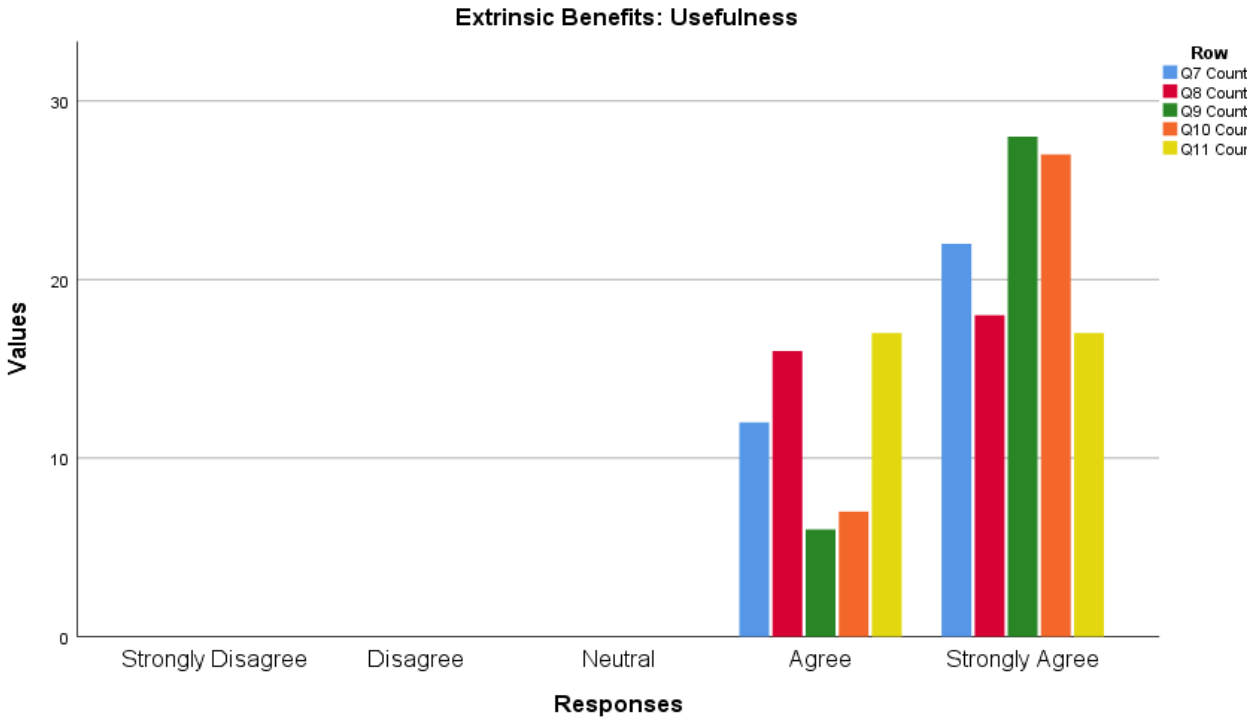
Figure 7: Perceived Value of Microservices Architecture Implementation (Source SPSS)

Majority of the respondents felt that Microservices architecture offered more value to the bank as opposed to costs of implementation at 85.3% (58.8%+26.5%). A significant number of respondents also indicated that Microservices Architecture was more beneficial to the Bank as

compared to the effort it takes to implement it in Digital Banking Solutions at 91.1% (52.9%+38.2%). Consequently, all the respondents agreed that Microservices architecture was more beneficial to the bank in comparison to the time it takes to implement it.

4.7. Extrinsic benefit: Usefulness

The researcher also sought to find out the benefits in terms of usefulness of Microservices Adoption to the organization. The findings are presented in Figure 8



		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Q7	Row N %	0.0%	0.0%	0.0%	35.3%	64.7%
Q8	Row N %	0.0%	0.0%	0.0%	47.1%	52.9%
Q9	Row N %	0.0%	0.0%	0.0%	17.6%	82.4%
Q10	Row N %	0.0%	0.0%	0.0%	20.6%	79.4%
Q11	Row N %	0.0%	0.0%	0.0%	50.0%	50.0%

Figure 8: Extrinsic Benefit Usefulness (Source SPSS)

The study findings indicate that 64.7% of the respondents strongly believed that implementation of Microservices architecture improved the scalability of its digital banking solutions while 35.3% Agreed. 52.9% strongly indicated that microservices architecture had led to Improved agility and flexibility of the banks digital banking solutions with 47.1% Agreeing. With regard to Better fault

isolation and resilience of the banks digital banking solutions, 82.4 percent of the respondents strongly agreed and 17.6% agreed that indeed the implementation of Microservices Architecture had led to enhance fault isolation and resilience.

Furthermore, 79.4% of the respondents strongly intimated that implementation of microservices architecture had led to Faster time-to-market of the banks digital banking solutions with 20.6% agreeing. Perhaps due to the isolation of services based on functionality making it easy to perform upgrades on microservices as opposed to the entire application.

Collaboration had also been enhanced via implementation of Microservices Architecture with 50% agreeing and 50% strongly agreeing to the statement. This was with regard to making upgrades/updates on the banks digital Banking solutions.

4.8. Intrinsic benefit: Enjoyment

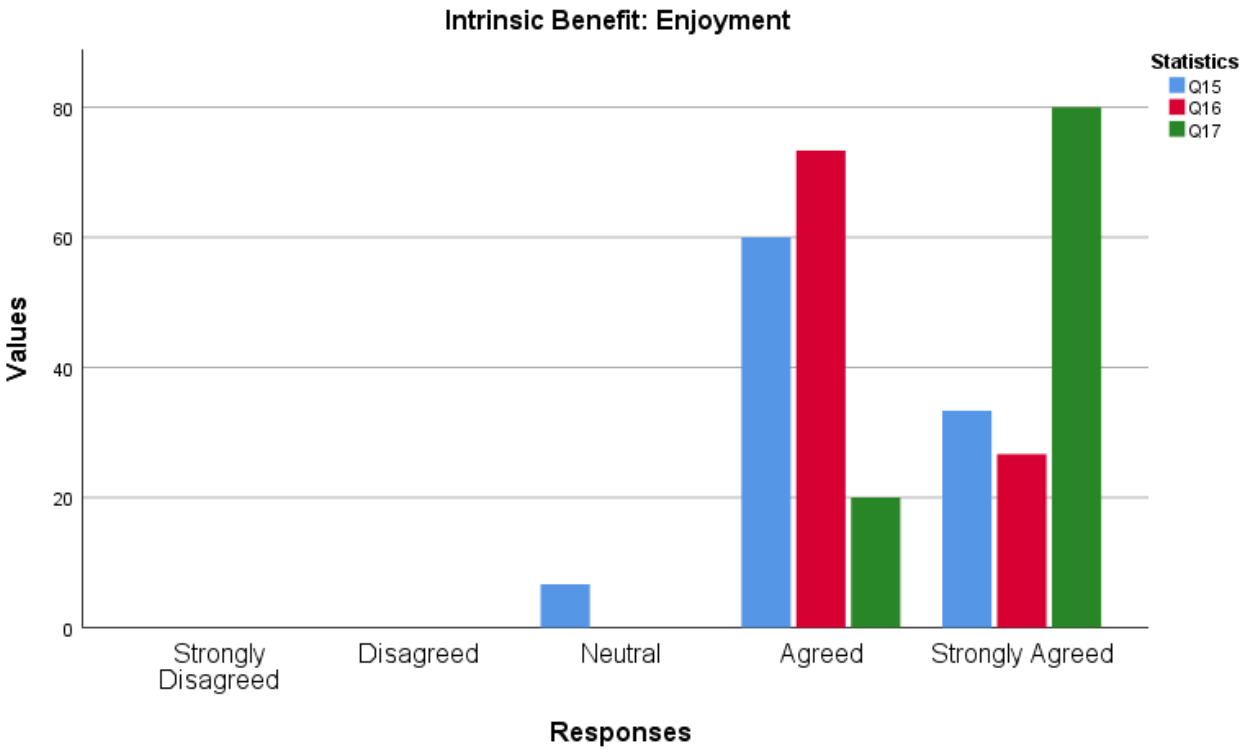
The researcher explored the intrinsic benefits of Microservices Architecture and particularly enjoyment. The findings are presented in Figure 9

The study findings indicate that 93.3% (60.0% + 33.3%) of the respondents enjoyed the Faster and Seamless User Experience on the digital banking solution after Adoption of microservices architecture. Only 6.7% of the respondents gave a Neutral response perhaps due to not having noted any difference.

Furthermore, 73.3% of the respondents agreed that they enjoyed the Personalization and Contextual Banking from the digital banking solution after Microservice architecture adoption with 26.7% strongly agreeing.

Agility and reliability was a major factor with 80% of the respondents agreeing that implementation of Microservices Architecture had brought agility and reliability benefits. This

could be attributed to on demand scaling perhaps at the microservice level based on user's demands/activity. 20% of the respondents also agreed to this benefit.

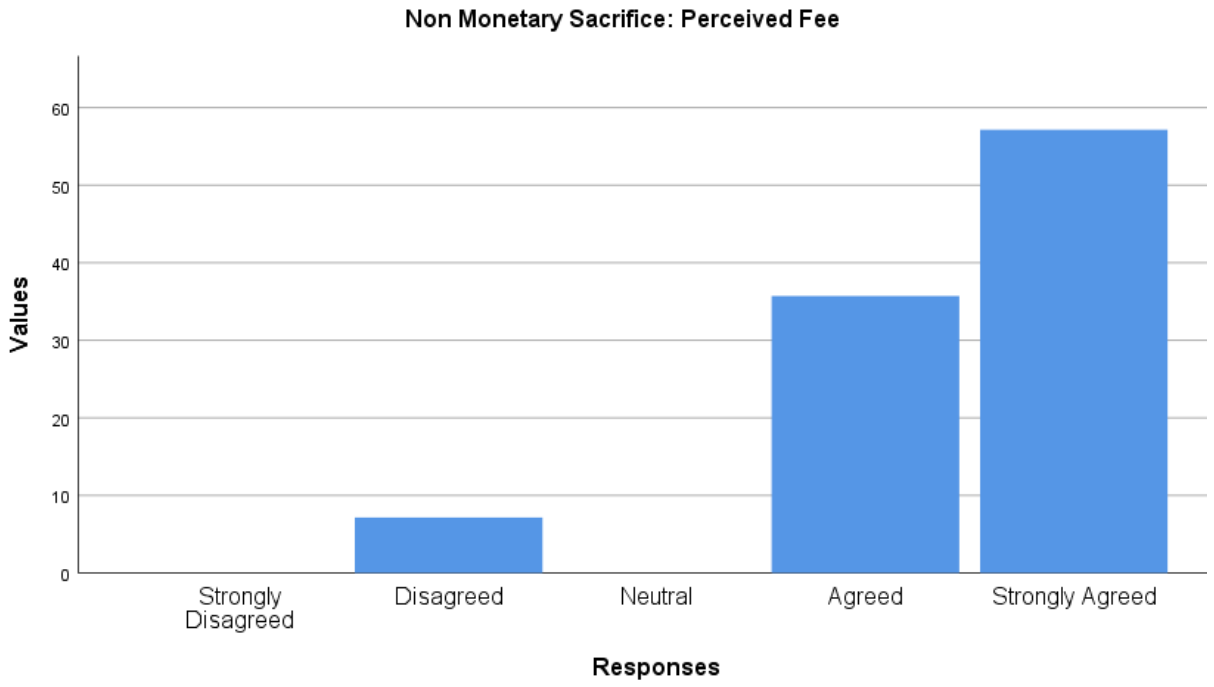


	Strongly Disagreed	Disagreed	Neutral	Agreed	Strongly Agreed
Q15	0.0%	0.0%	6.7%	60.0%	33.3%
Q16	0.0%	0.0%	0.0%	73.3%	26.7%
Q17	0.0%	0.0%	0.0%	20.0%	80.0%

Figure 9: Intrinsic Benefit Enjoyment (Source SPSS)

4.9. Non-monetary sacrifice: perceived fee

The study also assessed the effect of costs on Microservices Implementation and whether or not this was reasonable as an investment. The findings are presented in Figure 10



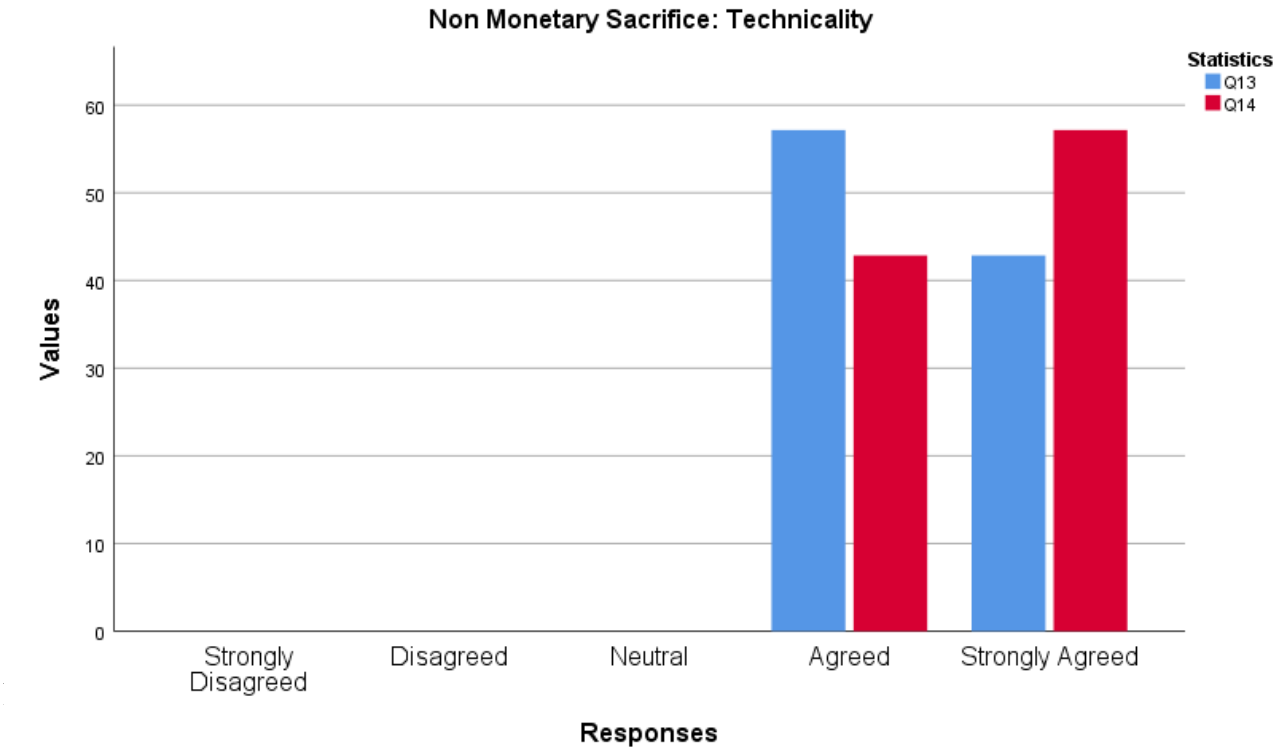
	Strongly Disagreed	Disagreed	Neutral	Agreed	Strongly Agreed
Q12	0.0%	7.1%	0.0%	35.7%	57.1%

Figure 10: Non-Monetary Benefit Perceived Fee (Source SPSS)

A number of respondents indicated that the costs of Microservices Implementation in digital Banking solutions was unreasonable at 7.1%. However, majority of the respondents believed that the costs of implementation were reasonable at 92.9%. This could be attributed to users perhaps looking at the cost of ownership over a prolonged period of time, versus what the banks currently spend to maintain monolithic and legacy systems.

4.10. Non-monetary sacrifice: technicality

Another key aspect that the researcher explored was the technicality with regard to ease of use of the digital banking solutions after microservices architecture implementation. The results are presented in Figure 11



	Strongly Disagreed	Disagreed	Neutral	Agreed	Strongly Agreed
Q13	0.0%	0.0%	0.0%	57.1%	42.9%
Q14	0.0%	0.0%	0.0%	42.9%	57.1%

Figure 11: Non-Monetary Sacrifice technicality (Source SPSS)

Majority of the respondents indicated that implementation of microservices architecture had reduced downtime in the banks digital banking solutions with 57.1% agreeing to this statement and 42.9 strongly agreeing. This can be attributed to the fact that, there are no need for scheduled

downtimes to make patches, upgrades or updates as instances of the microservices are patched or updated then just brought to live without necessarily bringing down all the instances. 100% of the respondents also indicated that digital banking solutions had become much faster after implementation of microservices architecture, perhaps as a result of microservices only required to load what is needed for its functionality rather than the entire application. This is also enhanced by on demand scaling in virtualized environments.

4.11 Hypothesis Testing

4.11.1. One-Sample *t*-test Test

The t-statistic in research is a ratio of the departure of the estimated value of a variable from its hypothesized value to a given standard error. One sample t-test is employed where data is from a single sample of participants, and the researcher wishes to understand whether the sample is similar to the hypothesized mean.

One-Sample Test						
	Test Value = 3.5					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
H1	13.212	33	.000	1.118	.95	1.29
H2	6.614	14	.000	.833	.56	1.10
H3	9.546	33	.000	.912	.72	1.11
H4	5.752	13	.000	1.000	.62	1.38
H5	7.648	33	.000	.706	.52	.89

Table 4: One-Sample t-test (Source SPSS)

The *t* column in the results table is the *t* -test statistic value where the larger the value t, the smaller the possibility that the outcome occurred by coincidence. The df column shows the degrees of freedom which signifies the size of the samples used. Sig (2-tailed) is the significance level (also

called the probability or *p*-value) shows the likelihood that the results have occurred by chance. To interpret the *t*- test results, focus is mainly focusing on the "Sig." column which is the *p* value for the test. If this value, $p < 0.001$ it means there is a significant relationship between the factors.

The first hypothesis being tested was:

H_1 Perceived usefulness does not have a positive effect on the perceived value of adoption of microservices architecture in digital banking solutions.

The *t*- test results yielded t (33) = 13.212, p (0.000) < 0.001. This means that there is a positive relationship between perceived usefulness and perceived value of adoption of microservices architecture in digital banking solutions. Since Perceived usefulness index is $\mu > 3.5$, this implies that the mean score of perceived usefulness index is above the neutral position. The researcher concluded that perceived value of adoption of microservices architecture is positively influenced by perceived usefulness and hence the hypothesis was rejected.

The second hypothesis of the study was:

H_2 Enjoyment does not have a positive effect on the perceived value of adoption of microservices architecture in digital banking solutions.

The *t*- test results returned t (14) = 6.614, p (0.00) < 0.001. Enjoyment index $\mu > 3.5$, as illustrated in Table 1. The study therefore, based on these results, concludes there is a significant relationship between Enjoyment and perceived value of adoption of microservices architecture in digital banking solutions. The hypothesis does not hold true and is therefore rejected.

H_3 Technicality does not have a negative effect on the adoption of microservices architecture in digital banking solutions.

The *t*- test results for the third hypothesis yielded the following findings; t (33) = 9.546, p (0.00) < 0.001. Similarly, Technicality had an index $\mu > 3.5$. This implies that there is a significant relationship between Technicality and perceived value of microservices architecture adoption in digital banking solutions. The hypothesis does holds true and is therefore accepted.

H_4 Perceived fee does not have a negative effect on the adoption of microservices architecture in digital banking solutions.

The *t*- test results for the fourth hypothesis yielded the following findings; t (13) = 5.752, p (0.00) < 0.001. Similarly, Perceived Fee had an index $\mu > 3.5$. This implies that there is a significant relationship between Perceived Fee and perceived value of microservices architecture adoption in digital banking solutions. The hypothesis holds true and is therefore accepted.

H_5 Perceived Value does not have a positive effect on the adoption of microservice architecture in digital banking solutions.

The moderating variable perceived value returned the following results from the *t*-test t (33) = 7.648, p (0.000) < 0.001, $\mu > 3.5$. This shows that the mean score of Perceived Value index is above the neutral position, as such, that there is a positive relationship between Perceived Value and Microservices Architecture adoption in digital banking solutions. The study therefore concludes that Perceived Value has a mediation effect on the adoption of microservices architecture in digital banking solutions. Consequently, the hypothesis is rejected as well.

4.11. Regression Analysis

4.11.1. Summary

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.926[a]	.858	.795	.235	.858	13.597	4	9	.001
a. Predictors: (Constant), Technicality, Enjoyment, Usefulness, Fee									

Table 5: Regression Analysis Model Summary (Source SPSS)

Table 5 reveals the outcome of multiple regression analysis when Enjoyment, Fee, Usefulness and Technicality against Perceived Value. The coefficient to determination is .858 which means that 85.8% of the variance in Perceived Value is explained by the independent variables. This suggest that there are some other factors that account for 14.2% of the variance in perceived value of Microservices Architecture Adoption which needs to be subjected to further research. Furthermore, there is a strong correlation as shown by a correlation coefficient of 0.926.

A regression of perceived value with the two benefits constructs (Usefulness and Enjoyment) revealed an R squared of 0.821. while a regression with sacrifices constructs (Ease of Use and Fee) shows a lower r squared of 0.672. This suggest that costs do not deter customers where they are attracted by the benefits.

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.906[a]	.821	.791	.236	.821	27.440	2	12	.000
a. Predictors: (Constant), Enjoyment, Usefulness									

Table 6: Regression analysis of Benefits with Perceived Value (Source SPSS)

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.820[a]	.672	.612	.323	.672	11.255	2	11	.002
a. Predictors: (Constant), Fee, Technicality									

Table 7: Regression analysis of Sacrifices with Perceived Value (Source SPSS)

4.11.2. ANOVA

The researcher carried out ANOVA analysis to ascertain the correlation between the dependent Variable Adoption Intention of Microservices Architecture and the Independent Variables (Fee, Usefulness, Enjoyment and Technicality). The outcome presented in Table 8 reveal that the relationship is significant at a 5% level of significance with a p-value <0.05.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.264	4	1.316	6.455	.000[b]
	Residual	8.971	44	.204		
	Total	14.235	48			
a. Dependent Variable: AdoptionIntention						
b. Predictors: (Constant), Technicality, Enjoyment, Usefulness, Fee						

Table 8: Analysis of Variance (Source SPSS)

4.11.2. Pearson's Correlation analysis between the variables

Correlations						
	AdoptionIntention	PerceivedValue	Enjoyment	Usefulness	Technicality	PerceivedFee
PerceivedValue	.465					
Enjoyment	.200	.258				
Usefulness	.490	.316	.000			
Technicality	.176	.076	.098	.239		
PerceivedFee	.100	.216	.056	-.547	-.082	.000

Table 9: Pearson correlation coefficient (Source SPSS)

From the correlation analysis in Table 9, all the constructs have a positive corelation with the Adoption intention with varying strengths of positive relationships. Usefulness and Perceived fee have negative relationships with each other as well as Perceived Fee and Technicality. The regression model was also tested for multicollinearity via collinearity statistics, the variance inflation factor (VIF) and tolerance. As a general rule, if VIF of a variable exceeds 10, then the variable can be termed as highly collinear and would pose a challenge to regression analysis.

Coefficients[a]										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.888	3.175		.280	.787	-6.432	8.209		
	PerceivedValue	.112	.427	.091	.262	.800	-.874	1.098	.793	1.261
	Enjoyment	.021	.448	.021	.046	.964	-1.012	1.054	.450	2.221
	Usefulness	.477	.528	.387	.903	.393	-.741	1.694	.520	1.924
	Technicality	.146	.390	.141	.375	.718	-.753	1.046	.672	1.488
	Fee	.033	.450	.033	.073	.944	-1.004	1.070	.471	2.123
a. Dependent Variable: AdoptionIntention										

Table 10: Multicollinearity Correlation (Source SPSS)

Despite the fact that a number of variables showed significant correlations, their tolerance values ranged from 0.046 to 0.903, while VIF values ranged from 1.261 to 2.221 as shown in Table 10, suggesting that multi-collinearity is not likely to threaten the study's parameter estimates.

The model from Table 10 was a s follows

$$\mathbf{Y= 0.888 + 0.112\ X_1 + 0.021\ X_2 + 0.477\ X_3 + 0.146\ X_4 + 0.033\ X_5}$$

Where Y is the adoption of microservices architecture, $\mathbf{X_1}$ Is the Perceived value $\mathbf{X_2}$ is enjoyment, $\mathbf{X_3}$ is usefulness, $\mathbf{X_4}$ is technicality, $\mathbf{X_5}$ is Fee

4.12. Discussion

The study sought to assess the Benefits and Sacrifices of microservices adoption in digital banking solutions among Kenyan commercial banks. The dependent variable was the adoption Intention while Benefits (Enjoyment and Usefulness) and Sacrifices (Perceived Fee and Technicality) were the independent variables.

The study revealed that 75% of the respondents were from institutions that had adopted Microservices architecture in their digital banking solutions, with only 25% having not adopted the technology. Respondents who had not implemented microservices architecture were not allowed to provide responses for the study questions as they were deemed not to have the necessary knowledge to provide useful responses.

The study also revealed that 94.1 percent of the respondents had future plans to adopt microservices architecture in their solutions. This is a strong indicator that the architecture is widely accepted in the financial services industry, perhaps due to its potential.

The findings from the study also partially supported the validity of the adopted research model which asserts that technology adoption is ascertained by perceptions of the value of the technology which are in turn determined by perceptions of the usefulness, enjoyment and sacrifices technicality and fee of the technology adoption. The study findings support three of the five hypotheses, indicating that benefits influence customer's intention to adopt microservices architecture. However, costs (Technicality and Fee) which according to the model ought to negatively impact adoption of microservices had positive effects as well. This is agreement with a study by (Chesbrough, 2023) which found out that benefits of open source software exceeded the costs.

In the banking industry technology is a major investment and a huge cost element every year, as such most respondents didn't believe that the cost of adoption was unreasonable especially in comparison to their current technologies as well as what microservices offers them. According to Liao, et al., 2022, the attitude of consumers towards adoption of a technology is prejudiced by the value that they receive from service which essentially denotes the perceived fee. Where the value that they obtain from the technology is greater than the costs that they spend, then the intent of the

purchaser shall be formed (Liao, et al., 2022). On the technicality element which the study adopted the Ease of use construct, respondents were also of the opinion that microservices architecture though complex to implement would translate to positive effects to maintain as well as significant performance benefits on the application level users.

CHAPTER 5: CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

5.1 Introduction

This study sought to assess the determinants for adoption of microservices architecture in digital banking solutions among Commercial banks in Kenya. The below objectives were set to be achieved by the end of the study: (1) To determine the effect of Benefits (Usefulness and Enjoyment) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks. (2) To assess the effect of Sacrifices (Ease of use and Fee) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks. (3) To examine the effect of perceived value on the adoption of microservices architecture in digital banking solutions among Kenyan Commercial Banks.

This chapter presents the study findings summary in the conclusion section, recommendations from the research findings and suggestions for future research. It presents summarized findings as per the research objectives, recommendations for microservices architecture adoption then suggestions for future research.

5.2 Summary

The study was conducted among 36 commercial banks in Kenya. A survey was carried out through Google survey to collect data from a target of 72 respondents. Inferential and descriptive statistical analysis was then carried out and results presented. A summary of the findings is presented in this subsection.

Majority of the respondents were males. Most of them (respondents) were aged between 31 and 50 years and preferred to use a computer/laptop over mobile devices including phones and tablets.

5.2.1 Effect of Benefits (Usefulness and Enjoyment) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks.

With respect to benefits, the study found out that Usefulness and Enjoyment significantly affect a user's perceived value of microservices architecture adoption. Furthermore, the study revealed that all the indicators of ease of use scalability, agility and flexibility, fault isolation and resilience, time to market and collaboration significantly affected their perceived value of Microservices architecture adoption. Similarly, enjoyment constructs including reliability, user experience and contextualization positively influenced perceived value of Microservices architecture adoption.

5.2.2 Effect of Sacrifices (Ease of use and Fee) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks.

The study also sought to determine the effect of sacrifices namely technicality and costs on perceived value of microservices architecture adoption. On the context of microservices architecture, it was revealed that cost was not a negative impediment to microservices adoption in digital banking solutions as its value outweighed the costs for the long term. In the Banking sector, technology is a major source of competitive advantage, given that digital banking also promotes open banking and stands to significantly reduce bank operational costs via physical branches, the value of microservices architecture implementation supersede the costs of implementation.

The study also revealed that technicality did not affect the perceived value of microservices architecture implementation. In a study where most of the respondents were technical ICT users, newer technologies tend to be complex at the start but then get less complex through training and learning. Based on present challenges and the opportunities provided by microservices architecture, respondents believed that this did not affect their perceived value of the microservices architecture.

5.2.3 Effect of perceived value on the adoption of microservices architecture in digital banking solutions among Kenyan Commercial Banks.

Finally, the researcher sought to ascertain the effect of perceived value on the adoption of microservices architecture in digital banking solutions. The results indicate that perceived value has a significant effect on the adoption intention, clearly supporting the value based technology adoption model. Additionally, it mediates the effects of benefits (usefulness, enjoyment), sacrifices (ease of use and fee) on adoption of microservices architecture. Nevertheless, the study failed to agree with the VBTAM with regard to technicality and costs being sacrifices to the perceived value of technology adoption. Perhaps this was constrained by the research questions which compared the sacrifices versus the value of microservices architecture adoption.

5.3 Conclusion

The aim of this study was to assess the determinants of adoption of microservices architecture in digital banking solutions among Kenyan commercial Banks. The study revealed that a significant number of banks have implemented or are in the process of implementing microservices architecture accounting to 76.6% (n=64), while the rest 23.4% had not implemented the microservices architecture. Furthermore, 94.1% of the respondents indicated that they had plans to adopt microservices architecture in the near future within the banks other technological solutions, with only 5.9% posting Neutral responses.

On the first objective, the study sought to determine the effect of technology Benefits (Usefulness and Enjoyment) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks. The study concluded that technology benefits usefulness and enjoyment had significant positive effect on perceived value of microservices architecture adoption. This was evidenced by p values (0.000) < 0.001 for benefit constructs (usefulness and

Enjoyment) within hypothesis testing. This is in agreement with the works of Muhamad, et al., 2021, Wang, et al., 2008 and Alborz, 2010.

The second objective of the study was to determine the effect of Sacrifices (Ease of use and Fee) on perceived Value of Microservices Architecture adoption in digital banking solutions in Kenyan Commercial banks. Contrary to the Value based technology model which indicated that these constructs have a negative effect to technology adoption, the study found that Technicality where the study adopted the Ease of Use construct as well as costs, positively affected the perceived value of microservices architecture adoption. This was as a result of comparison of long term costs to existing technology solutions as well as ease of use of digital banking solutions after microservices architecture implementation. Some studies revealed that reliability may affect the risk perception and consequently the satisfaction which individually influences the intention to adopt a technology (Park, et al., 2015; Regan, 2014; Martinez-Torres et al, 2008). This implies that where the anticipated reliability is greater, consumers are willing to forego risk elements such as costs and complexity and proceed to adopt a newer technology.

The third objective of the study was to determine the effect of perceived value on the adoption of microservices architecture in digital banking solutions among Kenyan Commercial Banks. Costs, effort and time needed to implement microservices architecture were considered as constructs of perceived value. Perceived value positively influenced microservice architecture adoption in Digital banking solutions among Kenyan Commercial banks. This is in agreement to the findings by Kim, et al., 2022, that perceived value positively affected the intention to adopt a technology.

Based on the findings, the study introduces new knowledge in that contrary to what the value based technology model suggests on technicality and costs constructs negatively affect technology adoption, this study reveals that where the perceived value is bigger, then costs and technicalities

don’t impede technology adoption. Furthermore, in industries such as sectors which are used to complex and costly technologies, users are more interested in the value of the technology to be adopted rather than its cost of acquisition and complexity.

5.4 Recommendations

Based on the research findings, the recommendations are as follows: The study advocates for more studies to be carried out more so from the end user perspective when implementing key financial software solutions. Users are the key stakeholders to any information technology solution hence, greater emphasis should be placed upon them. In order to foster or hasten microservices architecture adoption, technology players need to regularly publish comparative statistics to help other organizations to appreciate its benefits. More information will help address uncertainties particularly around technicalities of the architecture implementation.

Given that every new technology is perceived to be complex at the start majorly due to change management issues or believed to be costly based on initial implementations costs, sensitization needs to happen within the industry to help put into perspective all these concerns. This study also recommends that Banks need to commit a portion of their budgets into technology adoption to improve their competitive edges, Banks should continuously review the architecture of their solutions with respect to business needs as well as emerging technologies. Top ICT managers should also support new technology adoption processes and consider a broader IT strategic perspective when doing so.

5.5 Research Contribution

These study findings have improved our understanding of the determinants that influence technology adoption and specifically microservices architecture. The paper offers deep insights into the microservices architecture adoption drivers, it highlights the essence of benefits and

sacrifices in new technology adoption. A number of measures could be put in place to improve user perceptions particularly with regard to benefits and sacrifices of new technologies. For instance, training users in anticipated benefits along with the sacrifices to implement new technologies will give inexperienced users an opportunity to understand the implementation ecosystem as well as justifications for embracing the technologies.

Training could also help alleviate issues of technicality or perceived complexity of the microservices architecture, users could be educated on how microservices architecture will help improve their routine tasks, and create guided trainings on perceived technicalities.

Furthermore, understanding the relationship between the identified determinants is important if top ICT personnel are to understand their effects with regard to microservices implementation. This could be helpful in modelling adoption, usage as well as strategic positioning of partnerships and related innovative technologies to realize overall value for the respective organizations. For instance, all technologies adopted by a bank should be compatible or already architectured in a microservices standard.

A better understanding of determinants for microservices architecture adoption is also useful to key decision makers and ICT staff as they design and roll out new technology solutions. Importantly, knowledge gained could be helpful in realizing better throughput by coming up with actionable strategies on opportunities for improving microservices architecture adoption success.

It would also be worthy to consider organizations culture and structures. Conway's law asserts that software's reflect the communication structure of an organization. Given the interdependence of project teams is critical to microservice architecture implementation, it is also necessary to consider organizations command and communication levels.

This paper provides insights into the MA adoption drivers and their relationship to innovation process performance. It illustrates the importance of perceived usefulness and compatibility in innovation domains. A number of activities can be employed to enhance user perceptions regarding perceived usefulness of the MA. For example, training users in innovation management and introducing the concepts on which the MA is based, such as finding solutions to underlying issues rather than following linear processes, provides inexperienced users with an understanding of MA usefulness. Furthermore, training can provide guidance on how the MA can be used to suit the users' working routines and establish innovation-specific practices, thus, improving perceived compatibility.

Additionally, tracing interactions of identified determinants is crucial if managers are to understand their effects. This can help in shaping adoption and use and even the strategic positioning of partnerships in innovation networks to achieve advantageous alliances with innovation partners. An improved understanding of MA adoption could also be useful to managers and ICT professionals as they design and implement new MAs. Specifically, knowledge gained can be used to achieve greater efficiencies by developing actionable adoption strategies and policies for improving the chances of achieving MA adoption success.

This paper provides insights into the MA adoption drivers and their relationship to innovation process performance. It illustrates the importance of perceived usefulness and compatibility in innovation domains. A number of activities can be employed to enhance user perceptions regarding perceived usefulness of the MA. For example, training users in innovation management and introducing the concepts on which the MA is based, such as finding solutions to underlying issues rather than following linear processes, provides inexperienced users with an understanding of MA usefulness. Furthermore, training can provide guidance on how the MA can be used to

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Additionally, tracing interactions of identified determinants is crucial if managers are to understand their effects. This can help in shaping adoption and use and even the strategic positioning of partnerships in innovation networks to achieve advantageous alliances with innovation partners. An improved understanding of MA adoption could also be useful to managers and ICT professionals as they design and implement new MAs. Specifically, knowledge gained can be used to achieve greater efficiencies by developing actionable adoption strategies and policies for improving the chances of achieving MA adoption success

5.6 **Suggestion for Further Studies**

The study focused on Commercial Banks in Kenya and hence it would be ideal to also broaden the target population to also include Microfinance institutions, lending institutions and mobile money operators. While the study also focused on digital banking solutions, microservices architecture is also applicable to other technologies and it would be interesting to also conduct some comparative analysis with other industries. Additional studies are also required to identify other influencing determinants of microservices adoption. This is justified by the outcome of multiple regression which indicated that 85.8% of the variance in Perceived Value was explained by the independent variables implying that some other factors that accounted for 14.2% of the variance in perceived value of Microservices Architecture Adoption which needs to be subjected to further research. Given that the microservices architecture technology implementation is still relatively low, further research will help uncover other vital determinants of successful implementation.

References

Accenture. (2017). The future of banking: From digital learners to digital leaders. https://www.accenture.com/_acnmedia/PDF-55/Accenture-Future-Of-Banking.pdf#zoom=50

Alborz, B. (2010). Value-based adoption of mobile internet in Iran.

Alahmari, S., Zaluska, E., & De Roure, D. (2010, July). A service identification framework for legacy system migration into SOA. In 2010 IEEE International Conference on Services Computing (pp. 614-617). IEEE.

Alam, M., Rufino, J., Ferreira, J., Ahmed, S. H., Shah, N., & Chen, Y. (2018). Orchestration of microservices for iot using docker and edge computing. *IEEE Communications Magazine*, *56*(9), 118-123.

Baylov, K., & Dimov, A. (2016). IMPROVING BUSINESS PERFORMANCE THROUGH MICROSERVICES. Science. Business. Society., 1(2), 15-18.

Barbulescu, C. (2023, January). Microservices as a Key Enabler of a Cloud Native Architecture. In *Education, Research and Business Technologies: Proceedings of 21st International Conference on Informatics in Economy (IE 2022)* (pp. 3-9). Singapore: Springer Nature Singapore.

Baskarada, S., Nguyen, V., & Koronios, A. (2020). Architecting microservices: Practical opportunities and challenges. *Journal of Computer Information Systems*, *60*(5), 428-436.

Blumberg, B., Cooper, D., & Schindler, P. (2014). EBOOK: Business Research Methods. McGraw Hill.

Brown, J. D. (2001). Using surveys in language programs. Cambridge university press.

Bucchiarone, A., Dragoni, N., Dustdar, S., Larsen, S. T., & Mazzara, M. (2018). From monolithic to microservices: An experience report from the banking domain. *Ieee Software*, *35*(3), 50-55.

Central Bank of Kenya. (2021). BANK SUPERVISION ANNUAL REPORT. https://www.centralbank.go.ke/uploads/banking_sector_annual_reports/88445563_2021%20Annual%20Report.pdf

CHEREDNYCHENKO, M. (2020, December 4). Understanding the Nature of Cloud-Based Application Development. Softensy. https://softensy.com/understanding-the-nature-of-cloud-based-application-development/

Chesbrough, H. (2023). Measuring the Economic Value of Open Source A Survey and a Preliminary Analysis. THE LINUX FOUNDATION. https://project.linuxfoundation.org/hubfs/LF%20Research/Measuring%20the%20Economic%20Value%20of%20Open%20Source%20-%20Report.pdf?hsLang=en

Chironga, M., Cunha, L., De Grandis, H., & Kuyoro, M. (2018). Roaring to life: Growth and innovation in African retail banking. McKinsey & Company.

Creswell, J. W. (2009). Research designs: Qualitative, quantitative, and mixed methods approaches. California: Sage.

Cresswell, J. W. (2012). Educational research: Planning, conducting and evaluating quantitative research. Boston: Person Education.

Cronin, J. J., Brady, M. K., Brand, R. R., Hightower Jr, R., & Shemwell, D. J. (1997). A cross-sectional test of the effect and conceptualization of service value. Journal of services Marketing, 11(6), 375-391.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS quarterly, 319-340.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management science*, *35*(8), 982-1003.

Deci, E. L. (1971). Effects of externally mediated rewards on intrinsic motivation. *Journal of personality and Social Psychology*, *18*(1), 105.

Deloitte. (2019). Future of banking: Embracing open banking with microservices. https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/financial-services/deloitte-nl-future-of-banking-embracing-open-banking-with-microservices.pdf

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. Journal of management information systems, 19(4), 9-30.

Dragoni, N., Giallorenzo, S., Lafuente, A. L., Mazzara, M., Montesi, F., Mustafin, R., & Safina, L. (2017). Microservices: yesterday, today, and tomorrow. *Present and ulterior software engineering*, 195-216.

ENTERPRISE MANAGEMENT ASSOCIATES. (2016). Omnichannel, Microservices, and "Modern" Applications How Are YOU Managing User Perceptions and the Customer Experience? https://btbilgi.com.tr/wp-content/uploads/2019/06/ema-omnichannel-microservices-and-modern-applications.pdf.

Ferguson, I. (2022, April 11). Microservices: Does Cost and Complexity Justify Speed and Agility? Alibaba Cloud Community. https://www.alibabacloud.com/blog/microservices-does-cost-and-complexity-justify-speed-and-agility_598807

Fowler, M. (2019, 08 1). MartinFowler.com. Retrieved from https://martinfowler.com/agile.html

Grewal, S., & Harmsen, S. (2018). The adoption of microservices in the banking industry. In Proceedings of the 2018 IEEE 20th Conference on Business Informatics (CBI) (pp. 21-29). IEEE. https://doi.org/10.1109/CBI.2018.00012

Haegele, J. A., & Hodge, S. R. (2015). Quantitative methodology: A guide for emerging physical education and adapted physical education researchers. The Physical Educator, 72(5).

Hall, B. H., & Khan, B. (2003). Adoption of new technology.

Hoare, C. A. R. (1972). Hierarchical Program Structures. Structured Programming.

Jackson, M. A. (1975). Principles of Program Design.

Jbssolutions. (2021, March). MICROSERVICES: The good, the bad, and the better Using Microservices as a Wrapper for a Faster, Less Risky Approach to Delivering New Business Value.

Kalske, M., & Mäkitalo, N. (2018). Challenges When Moving from Monolith to Microservice Architecture. Current Trends in Web Engineering (pp. 32-47). Cham: Springer International Publishing.

Kim, H. W., Chan, H. C., & Gupta, S. (2007). Value-based adoption of mobile internet: an empirical investigation. *Decision support systems*, *43*(1), 111-126.

Kim, D. K., Kim, N. H., Oh, C. Y., Jang, J., Nho, H., & Park, S. U. (2022). Effect of a Taekwondo Academy's Technology-Based Self-Service on Perceived Value and Intention to Use Continuously in the Interaction between Humans and Technology. *Applied Sciences*, *12*(23), 12420.

Kothari, C. R. Garg, G. (2004). *Research methodology: methods and techniques* (2nd Edition), New Delhi: New Age International publisher, 2004, P. 31. Research Methodology 26

Kothari, C., & Garg, G. (2014). Research methodology: Methods and Techniques, Third edit. ed. New age international (p) limited, publishers.

Krueger, C. (2022, June 7). Auto & equipment finance microservices. Retrieved March 9, 2023, from Accenture Banking Blog website: https://bankingblog.accenture.com/how-microservices-could-be-your-fast-path-to-growth

Kshetri, N. (2010, January). Cloud computing in developing economies: drivers, effects, and policy measures. In Proceedings of PTC (pp. 1-22).

Larrucea, X., Santamaria, I., Colomo-Palacios, R., & Ebert, C. (2018). Microservices. *IEEE Software*, *35*(3), 96-100.

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. Information & management, 40(3), 191-204.

Liao, Y. K., Wu, W. Y., Le, T. Q., & Phung, T. T. T. (2022). The integration of the technology acceptance model and value-based adoption model to study the adoption of e-learning: The moderating role of e-WOM. *Sustainability*, *14*(2), 815.

Lipton, A., Shrier, D., & Pentland, A. (2016). *Digital banking manifesto: the end of banks?*. USA: Massachusetts Institute of Technology.

Mannello, M., Falcarin, P., & Romano, F. (2018). Microservices in banking: a systematic mapping study. Journal of Systems and Software, 138, 235-257. https://doi.org/10.1016/j.jss.2017.12.007

Martinez-Torres, M., Toral Marin, S., Garcia, F., Vazquez, S., Oliva, M. and Torres, T. (2008). A technological acceptance of e-learning tools used in practical and laboratory teaching, according to the European higher education area. Behaviour & Information Technology, 27(6), pp. 495-505.

Maruyama, G., & Ryan, C. S. (2014). Research methods in social relations. John Wiley & Sons.

Mazlami, G., Cito, J., & Leitner, P. (2017, June). Extraction of microservices from monolithic software architectures. In *2017 IEEE International Conference on Web Services (ICWS)* (pp. 524-531). IEEE.

Mazzara, M., Dragoni, N., Bucchiarone, A., Giaretta, A., Larsen, S. T., & Dustdar, S. (2017). Microservices: Migration of a Mission Critical System. IEEE TRANSACTIONS ON SERVICES COMPUTING, VOL. 14, NO. 5, SEPTEMBER/OCTOBER 2021.

McKinsey (2023) Growth & Innovation: Helping to identify, accelerate, organize and mobilize large organizations for outsized growth, McKinsey. Available at: https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/how-we-help-clients/growth-and-innovation (Accessed: 2023).

Mezzalira, F., & Lopes, F. (2016). Microservices and the evolution of software architecture in the banking industry. In Proceedings of the 2016 IEEE 10th International Conference on Research Challenges in Information Science (RCIS) (pp. 1-12). IEEE. https://doi.org/10.1109/RCIS.2016.7549399

Microsoft. (2021, 09 15). docs.microsoft.com. Retrieved from https://docs.microsoft.com/en-us/dotnet/architecture/microservices/architectmicroservice-container-applications/communication-in-microservice-architecture.

Mike Loukides, S. S. (2020, July 15). *Microservices adoption in 2020*. O'Reilly Media. https://www.oreilly.com/radar/microservices-adoption-in-2020/

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information systems research*, *2*(3), 192-222.

Muhamad, E. A., Maulana, A. E., Heriyati, P., & Wiweka, K. (2021). Investigating the Effects Perceived Value, Technology Adoption, the Level of Value Orientation, and Customer

Satisfaction on Buyer Engagement of B2B Marketplace in Indonesia. *Investigating the Effects Perceived Value Technology Adoption the Level of Value Orientation and Customer Satisfaction on Buyer Engagement of B2B Marketplace in Indonesia Systematic Reviews in Pharmacy*, *12*, 1459-1478.

Musawa, M. S., & Wahab, E. (2012). The adoption of electronic data interchange (EDI) technology by Nigerian SMEs: A conceptual framework. Journal of Business Management and Economics, 3(2), 55-68.

Nadareishvili, I., Mitra, R., McLarty, M., & Amundsen, M. (2016). *Microservice architecture: aligning principles, practices, and culture*. " O'Reilly Media, Inc.".

Newman, S. (2015). Building microservices: designing fine-grained systems. " O'Reilly Media, Inc."

Owino, J. (2020) NCBA Upgrades M-Shwari Platform To Improve Reliability Of Services, CapitalFM. Available at: https://www.capitalfm.co.ke/business/2020/12/ncba-upgrades-m-shwari-platform-to-improve-reliability-of-services/ (Accessed: 2023).

Ostertagová, E & Ostertag, O. (2013). Methodology and Application of One-way ANOVA. *American Journal of Mechanical Engineering*, Vol. 1(7), pp.256-261.

Park, E., Kim, H., Ohm, J. Y. (2015). Understanding driver adoption of car navigation systems using the extended technology acceptance model. Behaviour and Information Technology, 34(7), pp. 741-751.

Prathap, I., & Saravanan, P. (2019). Adoption Advantages of Micro-Service Architecture in Software Industries. *Int. J. Sci. Technol. Res*, *8*, 183-186.

Premkumar, G. (2003). A meta-analysis of research on information technology implementation in small business. Journal of organizational computing and electronic commerce, 13(2), 91-121.

Redhat. (2019). Deutsche Bank democratizes development with Red Hat-based global platform. Customer Case Study. https://www.redhat.com/cms/managed-files/rh-deutche-bank-case-study-f16600wg-201904-en.pdf

Regan, M., Horberry, T., Stevens, A. (2014). Driver acceptance of new technology.

Rogers, E. M. (1995). Diffusion of innovations–5th edition Free Press. *New York*.

SaM Solutions. (2017). Microservices vs. Monolithic: Real Business Examples. Retrieved April 22, 2018, from https://www.sam-solutions.com/blog/microservices-v

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research methods for business students. Pearson education.

Scardovi, C. (2017). *Digital transformation in financial services* (Vol. 236). Cham: Springer International Publishing.

Seddon, P. B. (1997). A respecification and extension of the DeLone and McLean model of IS success. Information systems research, 8(3), 240-253.

Shadija, D., Rezai, M., & Hill, R. (2017, December). Microservices: granularity vs. performance. In *Companion Proceedings of the10th International Conference on Utility and Cloud Computing* (pp. 215-220).

Shaikh, A. A., & Karjaluoto, H. (2016). On some misconceptions concerning digital banking and alternative delivery channels. *International Journal of E-Business Research (IJEBR)*, *12*(3), 1-16.

Shaikh, D., Ara, A., Kumar, M., Syed, D., Ali, A., & Shaikh, M. Z. (2021). A two-decade literature review on challenges faced by SMEs in technology adoption. *Academy of Marketing Studies Journal*, *25*(3).

Singleton, A. (2016). The Economics of Microservices. IEEE Cloud Computing, 3(5), 16–20.

https://doi.org/10.1109/MCC.2016.109

Snyder, A. (1993). The essence of objects: Common concepts and terminology. IEEE Software.

Söylemez, M., Tekinerdogan, B., & Kolukısa Tarhan, A. (2022). Challenges and Solution Directions of Microservice Architectures: A Systematic Literature Review. Applied Sciences, 12(11), 5507.

Steenkamp, J. B. E. (1990). Conceptual model of the quality perception process. *Journal of Business research*, *21*(4), 309-333.

Sturtevant, D. (2018). Modular Architectures Make You Agile in the Long Run. IEEE Software, 35(1), 104–108. https://doi.org/10.1109/MS.2017.4541034

Sun, L., Li, Y., & Memon, R. A. (2017). An open IoT framework based on microservices architecture. *China Communications*, *14*(2), 154-162.

Thaler, R. (1985). Mental accounting and consumer choice. *Marketing science*, *4*(3), 199-214.

Tornatzky, L. G., Fleischer, M., & Chakrabarti, A. K. (1990). Processes of technological innovation. Lexington books.

Trivedi, A. (2022, November 26). Capital One: Transforming traditional banking to an AI-first experience. Digital Initiative. https://d3.harvard.edu/platform-digit/submission/capital-one-transforming-traditional-banking-to-an-ai-first-experience/

Van Wyk, B. (2012). Research design and methods Part I. *University of Western Cape*.

Vesterlund, M., Suomalainen, T., & Mikkonen, T. (2019). Microservices architecture and adoption: A systematic literature review. Journal of Systems and Software, 157, 110392. https://doi.org/10.1016/j.jss.2019.110392

Villamizar, M., Garcés, O., Castro, H., Verano, M., Salamanca, L., Casallas, R., & Gil, S. (2015). Evaluating the monolithic and the microservice architecture pattern to deploy web

applications in the cloud. In 2015 10th Computing Colombian Conference (10CCC) (pp.583–590). https://doi.org/10.1109/ColumbianCC.2015.7333476

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS quarterly, 425-478.

Vishnuvardhan, B., Manjula, B., & Lakshman Naik, R. (2020). A study of digital banking: Security issues and challenges. In *Proceedings of the Third International Conference on Computational Intelligence and Informatics: ICCII 2018* (pp. 163-185). Springer Singapore.

Wang, Y., Meister, D., & Wang, Y. (2008). Relative advantage and perceived usefulness: The adoption of competing ICTs. *DIGIT 2008 Proceedings*, 6.

Wavomba, P., & Sikolia, S. F. (2015). Research in the quality of service delivery in public hospitals, Kenya.

Wewege, L. (2017). The digital banking revolution. Lulu. com.

APPENDICES

APPENDIX I: Research Questionnaire 1 (IT Directors, IT Managers)

Please, read the following informed consent information and select the survey link below if you agree to participate in the study.

Please, read the following informed consent information and select the survey link below if you agree to participate in the study.

My Name is Kipyego Felix. I am a Master's student undertaking this research under the supervision of Dr. Wanjiku Nganga at the department of Computing and Informatics, University of Nairobi. It should take approximately 10-20 minutes to complete this survey.

The purpose of this study is to expand the understanding of the different elements that influence the adoption of Microservices architecture in Commercial Banks in Kenya. The study's findings will be useful to offer practical recommendations to information technology heads, policy makers and banks on measures that will lead to effective adoption of Microservices Architecture in Commercial Banks.

Microservices architecture are a way of building software applications as a collection of independent, small, modular services that work together to provide a complete solution. The approach to software development is particularly well-suited for building large-scale, complex systems that require a high level of scalability, resilience, and agility. The architecture is built on the ideas of SOA, but with a focus on simplicity, agility, and independence. They are designed to be lightweight, with each service having a single responsibility and a minimal footprint. This allows for faster development cycles, easier testing and deployment, and better scalability and

resilience. Microservices also embrace a DevOps culture, where developers and operations teams work closely together to ensure that the software is delivered quickly and reliably.

The study requires that the bank employees within the ICT department as well as digital solutions end users fill the questionnaire as per the guidelines provided.

Your participation in this survey is voluntary and you are free to decline to answer any specific question you do not wish to answer for any reason. There are no risks involved in participating in this study. The survey does not collect any information such as your name, IP Address or email address. Therefore, your responses shall remain anonymous and be treated with confidentiality. Data collected will only be used for the purpose of the study only.

Please contact Kipyego Felix with questions or concerns about this study via **felokip@students.uonbi.ac.ke**

Thank you so much for your cooperation.

I have read the above and agree to participate

1. Has your organization implemented Micro-services in its Digital Banking solutions?

YES	
NO	

2. Which of the below options best describes your current role?

Current Role	
Chief Executive Officer	
IT Manager	
Product/Program/Project Manager	
Developer or Software Engineer	
Systems Implementer	
System End User	

3. Kindly indicate your level of agreement to the statements below relating to factors affecting adoption of microservices. Use a scale of 1- **Strongly Disagree 2- Disagree 3- Neutral 4- Agree 5- Strongly Agree**

		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Adoption Intention						
	The Bank has plans of adopting Microservices in its Digital Banking Solutions or other solutions in the near future					
Perceived Value						
	Microservices architecture offers more value for money to the bank when compared to the cost of its adoption.					
	Microservices architecture is more beneficial to the bank when compared to the effort needed to implement it.					
	Microservices architecture is more beneficial to the bank when compared to the time needed to implement it.					
Extrinsic benefit: Usefulness						
	Adoption of microservices architecture has led to Increased Scalability of the banks digital banking solutions					
	Adoption of microservices architecture has led to Improved agility and flexibility of the banks digital banking solutions					

	Adoption of microservices architecture has led to Better fault isolation and resilience of the banks digital banking solutions					
	Adoption of microservices architecture has led to Faster time-to-market of the banks digital banking solutions					
	Adoption of microservices architecture has led to Improved Collaboration when implementing changes in the banks digital banking solutions					
Non-monetary sacrifice: Fee						
	The fee that the bank has to pay for the implementation of microservices architecture in digital banking solutions is reasonable.					
Non-monetary sacrifice: technicality						
	Adoption of Microservices architecture in digital banking solutions has made the banks applications much faster even during sessions with high traffic.					
	Adoption of microservices architecture has reduced downtime in the banks digital banking solutions.					

APPENDIX II: Research Questionnaire 2 (Project Managers, Software Developers & System Implementers)

Please, read the following informed consent information and select the survey link below if you agree to participate in the study.

Please, read the following informed consent information and select the survey link below if you agree to participate in the study.

My Name is Kipyego Felix. I am a Master's student undertaking this research under the supervision of Dr. Wanjiku Nganga at the department of Computing and Informatics, University of Nairobi. It should take approximately 10-20 minutes to complete this survey.

The purpose of this study is to expand the understanding of the different elements that influence the adoption of Microservices architecture in Commercial Banks in Kenya. The study's findings will be useful to offer practical recommendations to information technology heads, policy makers and banks on measures that will lead to effective adoption of Microservices Architecture in Commercial Banks.

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resilience. Microservices also embrace a DevOps culture, where developers and operations teams work closely together to ensure that the software is delivered quickly and reliably.

The study requires that the bank employees within the ICT department as well as digital solutions end users fill the questionnaire as per the guidelines provided.

Your participation in this survey is voluntary and you are free to decline to answer any specific question you do not wish to answer for any reason. There are no risks involved in participating in this study. The survey does not collect any information such as your name, IP Address or email address. Therefore, your responses shall remain anonymous and be treated with confidentiality. Data collected will only be used for the purpose of the study only.

Please contact Kipyego Felix with questions or concerns about this study via **felokip@students.uonbi.ac.ke**

Thank you so much for your cooperation.

I have read the above and agree to participate

1. Has your organization implemented Micro-services in its Digital Banking solutions?

YES	
NO	

2. Which of the below options best describes your current role?

Current Role	
Chief Executive Officer	
IT Manager	
Product/Program/Project Manager	
Developer or Software Engineer	
Systems Implementer	
System End User	

3. Kindly indicate your level of agreement to the statements below relating to factors affecting adoption of microservices. Use a scale of 1- **Strongly Disagree 2- Disagree 3- Neutral 4- Agree 5- Strongly Agree**

		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Adoption Intention						
	The Bank has plans of adopting Microservices in its Digital Banking Solutions or other solutions in the near future					
Perceived Value						
	Microservices architecture offers more value for money to the bank when compared to the cost of its adoption.					
	Microservices architecture is more beneficial to the bank when compared to the effort needed to implement it.					
	Microservices architecture is more beneficial to the bank when compared to the time needed to implement it.					
Extrinsic benefit: Usefulness						
	Adoption of microservices architecture has led to Increased Scalability of the banks digital banking solutions					
	Adoption of microservices architecture has led to Improved agility and flexibility of the banks digital banking solutions					

	Adoption of microservices architecture has led to Better fault isolation and resilience of the banks digital banking solutions					
	Adoption of microservices architecture has led to Faster time-to-market of the banks digital banking solutions					
	Adoption of microservices architecture has led to Improved Collaboration when implementing changes in the banks digital banking solutions					
Non-monetary sacrifice: technicality						
	Adoption of Microservices architecture in digital banking solutions has made the banks applications much faster even during sessions with high traffic.					
	Adoption of microservices architecture has reduced downtime in the banks digital banking solutions.					

APPENDIX III: Research Questionnaire 3 (Application End Users)

Please, read the following informed consent information and select the survey link below if you agree to participate in the study.

My Name is Kipyego Felix. I am a Master's student undertaking this research under the supervision of Dr. Wanjiku Nganga at the department of Computing and Informatics, University of Nairobi. It should take approximately 10-20 minutes to complete this survey.

The purpose of this study is to expand the understanding of the different elements that influence the adoption of Microservices architecture in Commercial Banks in Kenya. The study's findings will be useful to offer practical recommendations to information technology heads, policy makers and banks on measures that will lead to effective adoption of Microservices Architecture in Commercial Banks.

Microservices architecture are a way of building software applications as a collection of independent, small, modular services that work together to provide a complete solution. The approach to software development is particularly well-suited for building large-scale, complex systems that require a high level of scalability, resilience, and agility. The architecture is built on the ideas of SOA, but with a focus on simplicity, agility, and independence. They are designed to be lightweight, with each service having a single responsibility and a minimal footprint. This allows for faster development cycles, easier testing and deployment, and better scalability and resilience. Microservices also embrace a DevOps culture, where developers and operations teams work closely together to ensure that the software is delivered quickly and reliably.

The study requires that the bank employees within the ICT department as well as digital solutions end users fill the questionnaire as per the guidelines provided.

Your participation in this survey is voluntary and you are free to decline to answer any specific question you do not wish to answer for any reason. There are no risks involved in participating in this study. The survey does not collect any information such as your name, IP Address or email address. Therefore, your responses shall remain anonymous and be treated with confidentiality. Data collected will only be used for the purpose of the study only.

Please contact Kipyego Felix with questions or concerns about this study via **felokip@students.uonbi.ac.ke**

Thank you so much for your cooperation.

I have read the above and agree to participate

1. Has your organization implemented Micro-services in its Digital Banking solutions?

YES	
NO	

2. Which of the below options best describes your current role?

Current Role	
Chief Executive Officer	
IT Manager	
Product/Program/Project Manager	
Developer or Software Engineer	
Systems Implementer	
System End User	

3. Kindly indicate your level of agreement to the statements below relating to factors affecting adoption of microservices. Use a scale of 1- **Strongly Disagree 2- Disagree 3- Neutral 4- Agree 5- Strongly Agree**

		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Intrinsic benefit: Enjoyment						
	I enjoy the Faster and Seamless User Experience on the digital banking solution after Adoption of microservices architecture.					
	I enjoy the Personalization and Contextual Banking from the digital banking solution after Microservice architecture adoption.					
	I enjoy the Agility and Reliability on the digital banking solution after adoption of microservices architecture.					

APPENDIX IV: Data Analysis Coding of questions

NO	Question	Code
1	Has your organization implemented Micro-services in its Digital Banking solutions?	Q1
2	Which of the below options best describes your current role?	Q2
3	The Bank has plans of adopting Microservices in its Digital Banking Solutions or other solutions in the near future	Q3
4	Microservices architecture offers more value for money to the bank when compared to the cost of its adoption.	Q4
5	Microservices architecture is more beneficial to the bank when compared to the effort needed to implement it.	Q5
6	Microservices architecture is more beneficial to the bank when compared to the time needed to implement it.	Q6
7	Adoption of microservices architecture has led to Increased Scalability of the banks digital banking solutions	Q7
8	Adoption of microservices architecture has led to Improved agility and flexibility of the banks digital banking solutions	Q8
9	Adoption of microservices architecture has led to Better fault isolation and resilience of the banks digital banking solutions	Q9
10	Adoption of microservices architecture has led to Faster time-to-market of the banks digital banking solutions	Q10
11	Adoption of microservices architecture has led to Improved Collaboration when implementing changes in the banks digital banking solutions	Q11
12	The fee that the bank has to pay for the implementation of microservices architecture in digital banking solutions is reasonable.	Q12
13	Adoption of microservices architecture has reduced downtime in the banks digital banking solutions.	Q13
14	Adoption of Microservices architecture in digital banking solutions has made the banks applications much faster even during sessions with high traffic.	Q14
15	I enjoy the Faster and Seamless User Experience on the digital banking solution after Adoption of microservices architecture.	Q15
16	I enjoy the Personalization and Contextual Banking from the digital banking solution after Microservice architecture adoption.	Q16
17	I enjoy the Agility and Reliability on the digital banking solution after adoption of microservices architecture.	Q17